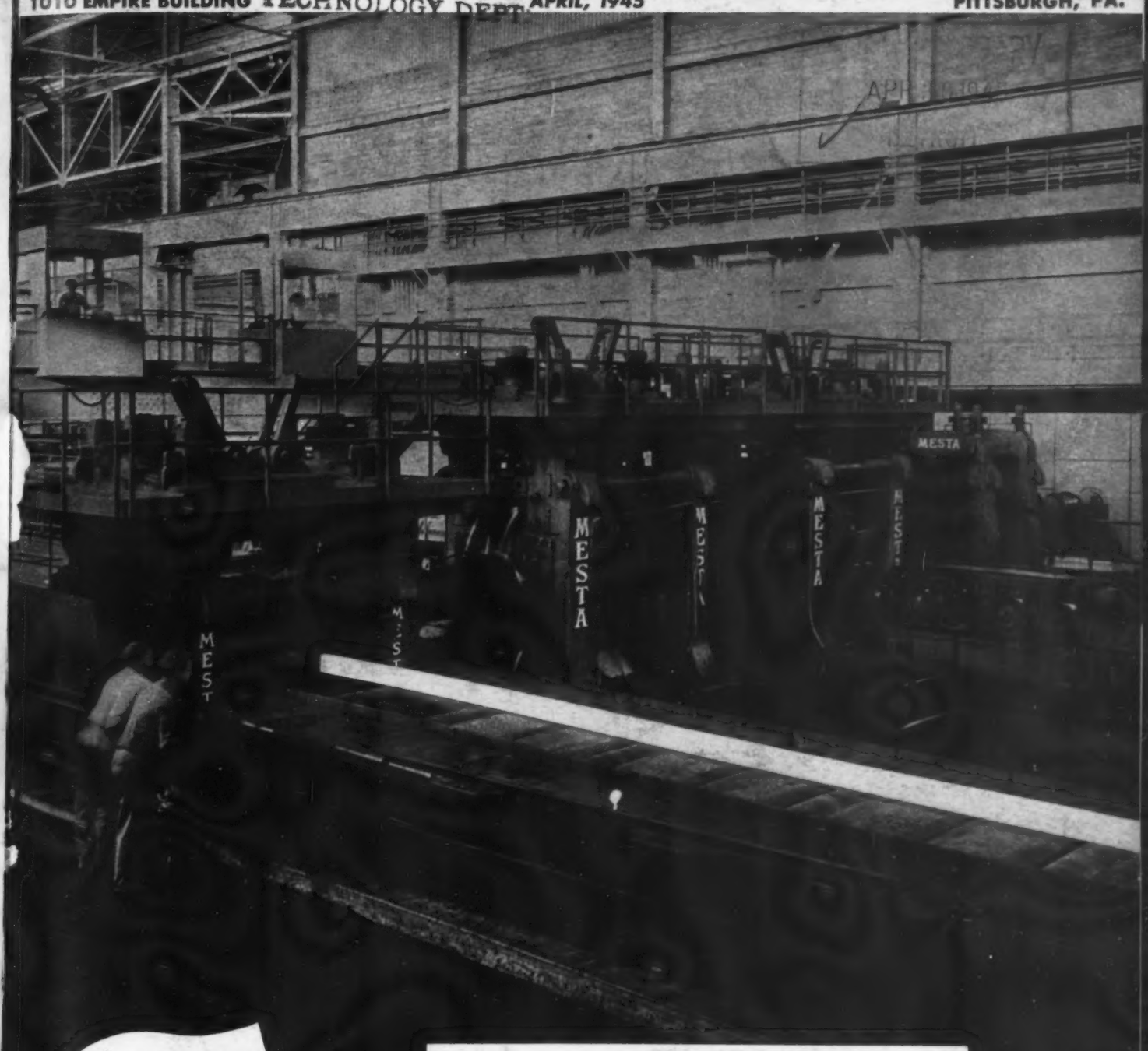
Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

1010 EMPIRE BUILDING TECHNOLOGY DEPT. APRIL, 1945 PITTSBURGH, PA.



The Army-Navy "E" Flag with four stars, flies over the Mesta Plant

Mesta 29" Structural Mill
Showing Traveling Tilting Table

MESTA MACHINE COMPANY · PITTSBURGH, PA.

With Cutler-Hammer Magnetic Clutches in or on your machines or equipment . . . engaging or disengaging at the touch of a button or by means of a limit switch, photoelectric cell or other device . . . you gain many advantages, and further degrees of automatic operation.

You can have automatic sequence of motions, the starting and stopping of parts of a cycle on automatic machines of many types.

You can have smooth, safe, swift, automatic engagement of the load where synchronous motors are used, after the motor is brought up to full speed.

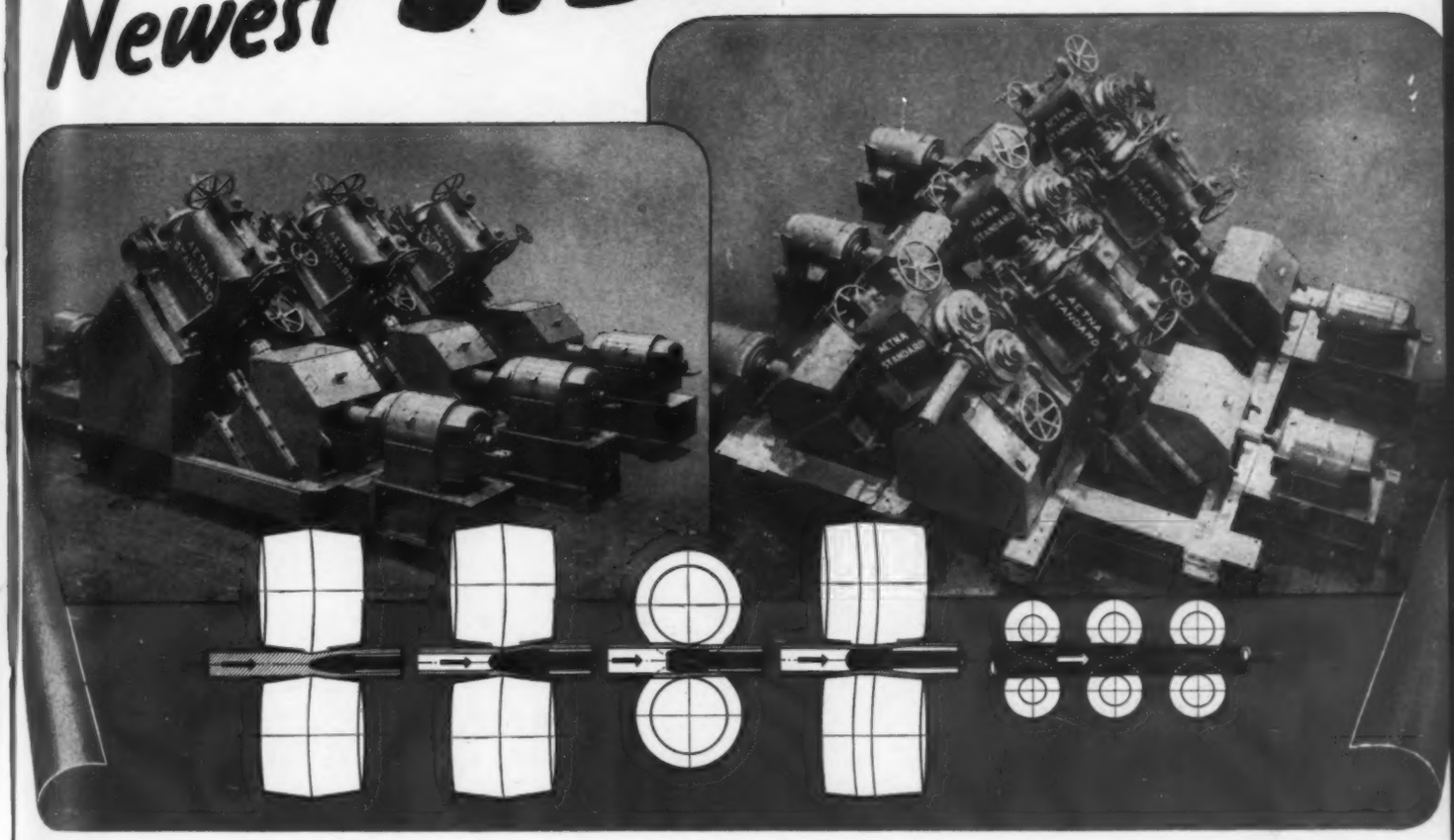
You can accelerate and lock into synchronism the various sections of a machine . . . guard various types of drives and machines against mechanical injury from jams and shocks . . . use C-H Magnetic Clutches as safety disconnect devices when brakes are suddenly set on high inertia drives.

There is a broad field of machine design advance awaiting your investigation of C-H Magnetic Clutches available in sizes from 7 inches to 78 inches in diameter. Write to Cutler-Hammer specialists today. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wisconsin. *Associate*: Canadian Cutler-Hammer, Ltd., Toronto, Ont.

CUTLER-HAMMER
MOTOR CONTROL
C-H

ANOTHER PRODUCT OF AETNA·STANDARD

AETNA·STANDARD'S Newest SIZING MILL



When our engineers set to work on the design of this sizing mill, they had one objective in mind . . .

make everything as easy for the operator as possible, so as to speed production by reducing "down time" and maintenance, thereby lowering costs per ton.

As a result, they incorporated several innovations and improvements:

a—An individual motor drive for each roll stand permits more flexible adjustment of speeds.

b—Roll shafts connected to drives by universal spindles assure consistent rigidity and smooth operation.

c—Overhanging of rolls cuts time for size change.

d—Design makes possible the changing of either rolls or complete housings. The rolls are 24" max. and 20" min. and will size tubes up to 9" O. D.

e—Hand wheels are provided for easy pass and groove adjustment.

f—Heavy, rigid construction, plus such features as antifriction bearings, assures positive, continuous operation. Once set, the mill will operate accurately without getting out of adjustment.

THE AETNA·STANDARD ENGINEERING COMPANY

YOUNGSTOWN, OHIO

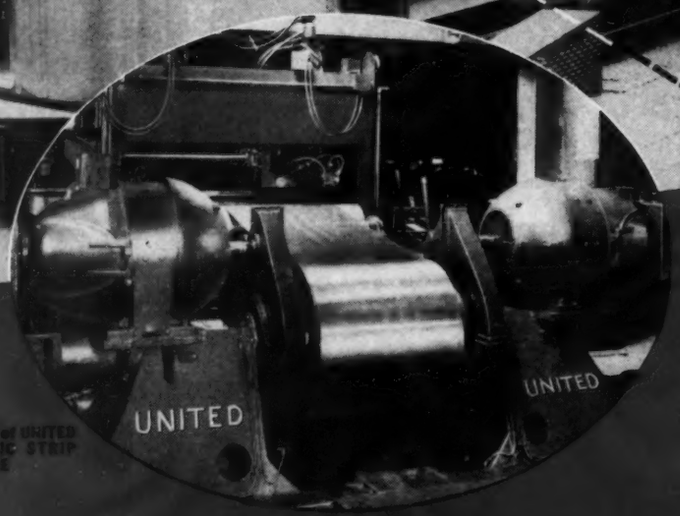
DESIGNERS AND BUILDERS to the Steel, Non-Ferrous and Chemical Industries.

ASSOCIATED COMPANIES:
HEAD, WRIGHTSON & COMPANY, LIMITED, THORNABY-ON-TEES, ENGLAND
JOHN INGLIS COMPANY, LIMITED, TORONTO, ONTARIO, CANADA

Aetna-Standard is the largest producer of seamless tube mills.

UNITED

UNITED ELECTROLYTIC STRIP CLEANING LINES showing Reeling Equipment



Reeling Unit of UNITED ELECTROLYTIC STRIP CLEANING LINE

Electrolytic Strip Cleaning Lines

26 United Electrolytic Strip Cleaning Lines Successfully Serving the Tinplate, Sheet and Non-ferrous Industries : . .

- New high standards of **speed, efficiency** and **economy** in the production of chemically clean cold rolled strip for subsequent electrolytic or hot dip coating have been established by UNITED ELECTROLYTIC CLEANING LINES in service both here and abroad.
- The coil and strip handling equipment is so coordinated with the cleaning units that a minimum of handling is required and **smooth, trouble-free operation** is assured.
- Introduction of the current in the electrolytic tank by "SOLUTION CONTACTS" instead of by mechanical contacts, **eliminates marking or marring** of the strip and **reduces strip breakage** to a minimum.
- If breakage occurs, UNITED'S full-length threading device will **cut the usual "production halt" by 90%.**
- Installations with **operating speeds in excess of 2000 F. P. M.** are in daily operation and incorporate many patented improvements.

Because we have greatly expanded our manufacturing facilities to meet war requirements, we will presently be able to offer attractive deliveries on duplications or modifications of existing designs of UNITED ELECTROLYTIC STRIP CLEANING LINES for handling practically all sizes of coils and gauges of metal, both ferrous and non-ferrous. Installation now may assure you of definite competitive advantages tomorrow. Consult our engineers for complete information and estimates.

The World's Largest Designers and Makers of Rolls and Rolling Mill Equipment

UNITED ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNNSYLVANIA

Plants at PITTSBURGH · VANDERGRIFT · NEW CASTLE · YOUNGSTOWN · CANTON

Davy and United Engineering Company, Ltd., Sheffield, England — Dominion Engineering Works, Ltd., Montreal, P. Q. Canada

Adamson United Company, Akron, Ohio

REG. T. M.

Photographs by courtesy of Inland Steel Company

Stud welded to Open-Hearth Door in ½ second!

The Nelson Stud Welder *automatically* end-welds studs to metal. Photo at Inland Steel shows stud welding of a hearth door before installing refractory ore.

Complete fusion of studs to metal results from flux-filled studs, automatic timing control, and a full-shielding of the arc.

Stud welding water-cooled Dog House. Studs are easily and accurately located.

To increase the life of hearth doors—to cut repair time—leading steel producers like Inland Steel are using Nelson Stud Welders. Doors are lasting as long as 150 heats. Studs are rapidly installed . . . are as strong as any hand stud welding application.

Thousands of stud welders are now being used by more than 500 shipyards and industrial plants. No welding experience necessary . . . Saves time, material, and labor.

For catalog, and report on "Stud Welding Hearth Doors", write:

NELSON SPECIALTY WELDING EQUIPMENT CORP.
Dept. 5, 440 Peralta Ave., San Leandro, Calif.

Eastern Representative:
Camden Stud Welding Corp., Dept. 122, 1416 So. 6th St., Camden, N. J.

NELSON STUD WELDERS

THE SECRET TO LOWER CONDITIONING COSTS WITH

SALEM CIRCULAR PITS

TO DISTRIBUTE HEAT uniformly in the Salem Circular Pit, multiple burners fire tangentially through the furnace sidewalls near the bottom of the chamber.

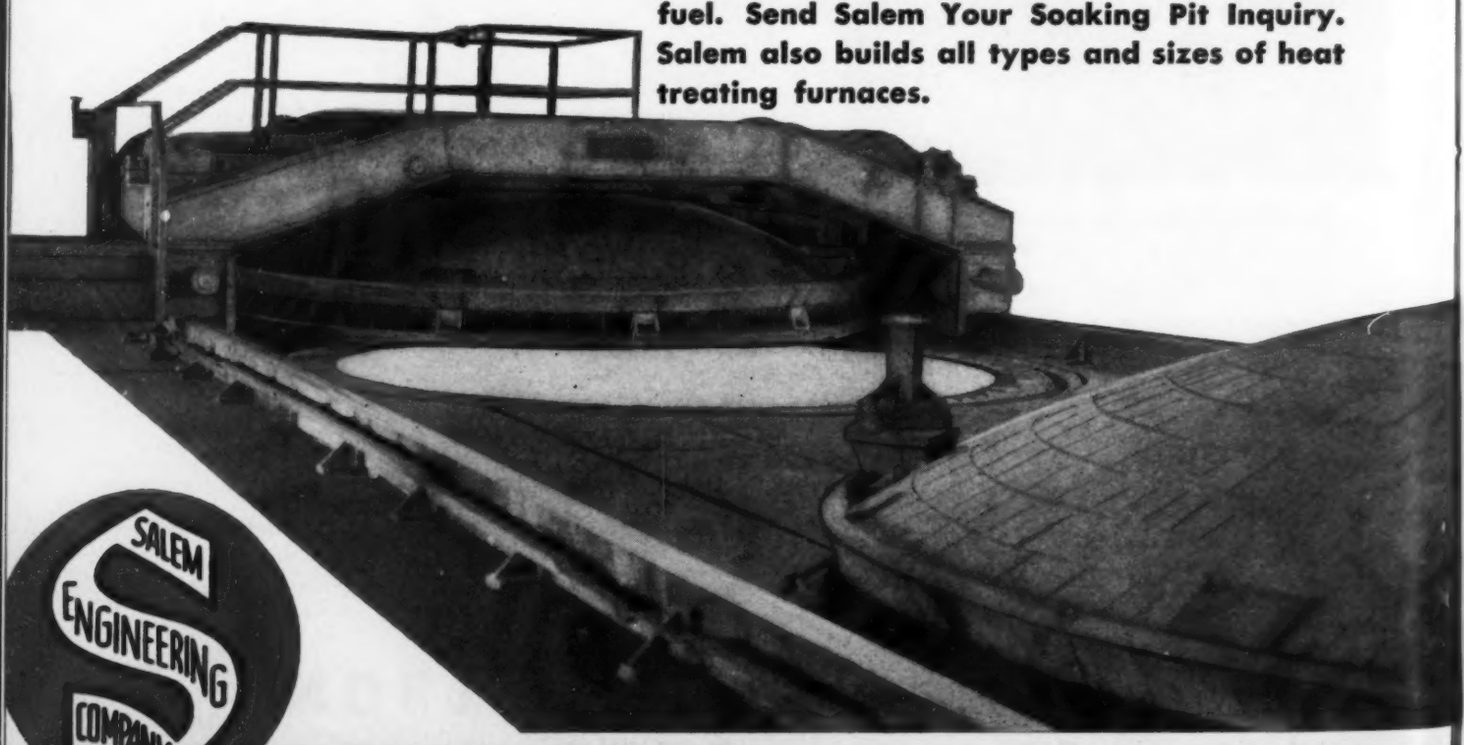
The products of combustion stir up a miniature tornado, diluting the hot gases formed at the burner pots, and transferring heat evenly to all the ingots. Before the gases exhaust through a center flue, they circle the chamber at least seven times.

And here's what one mill superintendent says about Salem's Engineered Heat and the Salem Circular Pit, an exclusive Salem development:

"You can prepare ingots faster, and you have less trouble in the entire operation than with any other type pit. I would like to have all Salem Circular Pits in our plants. Our records prove that we make substantial savings on each ton of steel prepared in our 20' Salem Circular Pit."

Send Salem Your Soaking Pit Inquiry . . .

Salem builds the Circular Pit in diameters between 8' and 20' utilizing any conventional fuel. Send Salem Your Soaking Pit Inquiry. Salem also builds all types and sizes of heat treating furnaces.



SALEM ENGINEERING COMPANY

SALEM ENGINEERING CO. · SALEM, OHIO

STAND A SHOCK?

CARBON AND GRAPHITE can be heated to incandescence and plunged into cold water without the slightest harmful effect!

This extraordinary resistance to thermal shock is the basis of many applications of "National" carbon and graphite and of "Karbate" products* in the metals, chemical, electronics, textile and other industries.

But these materials also have other equally important qualities. So you must think of them in terms of *all* their properties . . . in combinations possessed by no other materials.

It will help you to understand why carbon run-out troughs give up to six months' service in steel mills . . . why graphite anodes made the mercury-arc rectifier practical . . . why graphite molds for ferrous and nonferrous metals don't crack, spall or stick . . . why graphite bubble caps retain their original dimensions throughout the heat cycle of any chemical tower . . . and why "Karbate" heat exchangers resist practically all acids, alkalies and solvents.

Our nearest Division Office will gladly furnish full details.

*Impervious carbon or graphite.

The words "National" and "Karbate" are registered trade-marks of National Carbon Company, Inc.

BAR OF WHAT?
Carbon, Graphite, or "Karbate" materials, of course!

NATIONAL CARBON COMPANY, INC.
Unit of Union Carbide and Carbon Corporation
UCC
General Offices: 30 East 42nd Street, New York 17, N. Y.
Division Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

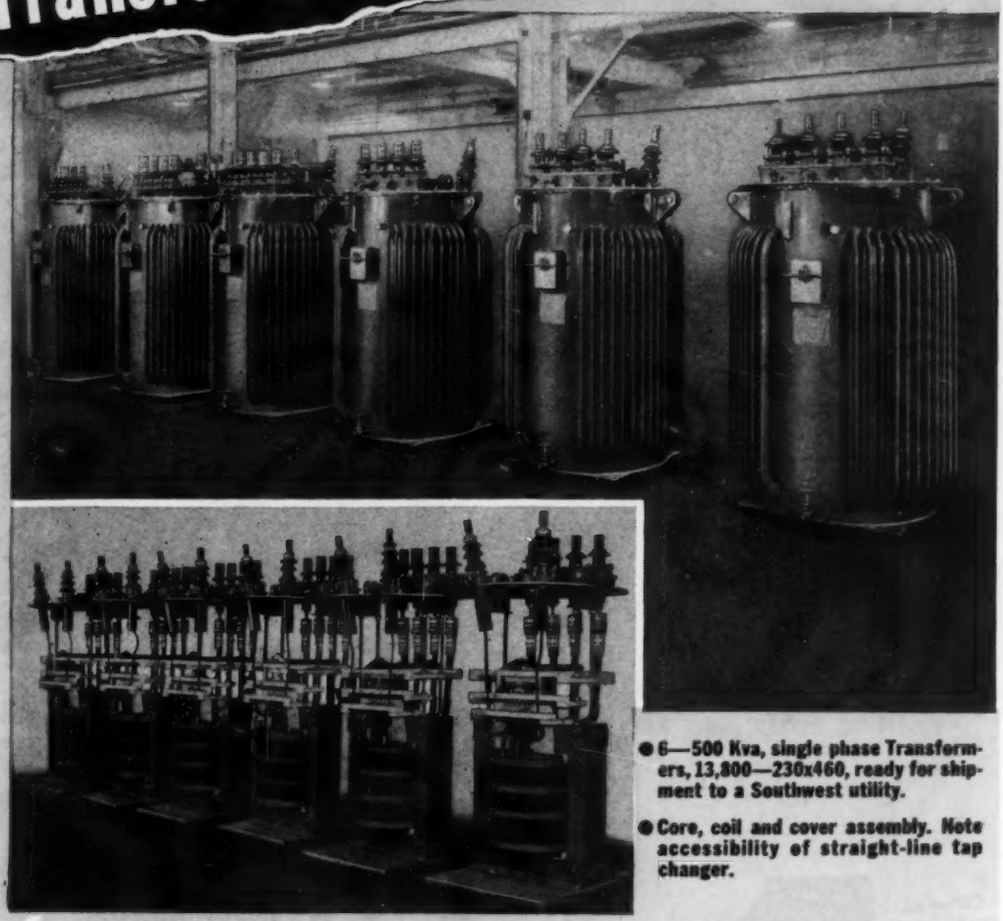
KEEP YOUR EYE ON THE INFANTRY . . . THE DOUGHBOY DOES IT!

Pennsylvania Distribution Substation Transformers

same general design as larger power transformers

◆

same rugged construction



● 6—500 Kva, single phase Transformers, 13,800—230x460, ready for shipment to a Southwest utility.

● Core, coil and cover assembly. Note accessibility of straight-line tap changer.

Check these important features

- Circular Coils
- Built-up Core Laminations
- Heavy Gauge Tank and Tubes (Tested with oil under pressure)
- High Short-time Overload Capacity
- Coordinated Insulation
- Rugged, Wet-process Porcelain Bushings (No cement used)

Pennsylvania TRANSFORMERS

Pennsylvania TRANSFORMER COMPANY
808 RIDGE AVENUE, N. S., PITTSBURGH 12, PA.

by BLAST FURNACE EQUIPPED WITH DE LAVAL BLOWER

All world's records for monthly production from a single furnace were recently broken by "B" Furnace of the Great Lakes Steel Corporation, Detroit. A total of 49,705 net tons of iron were produced in 31 consecutive working days. The tremendous and continuous supply of air required for this record-breaking production was furnished without interruption by an 85,000 c.f.m. De Laval blast furnace blower, which, during the same 31 day period, delivered close to 200,000 tons of air. Aside from routine inspection, this De Laval blower has been in practically continuous service since its installation in 1941.

De Laval turbines, blowers, gears and pumps can be depended upon for uninterrupted service at peak loads, wherever they serve.

M-42

TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS • CENTRIFUGAL PUMPS • CENTRIFUGAL BLOWERS and COMPRESSORS • IMO OIL PUMPS

DE LAVAL

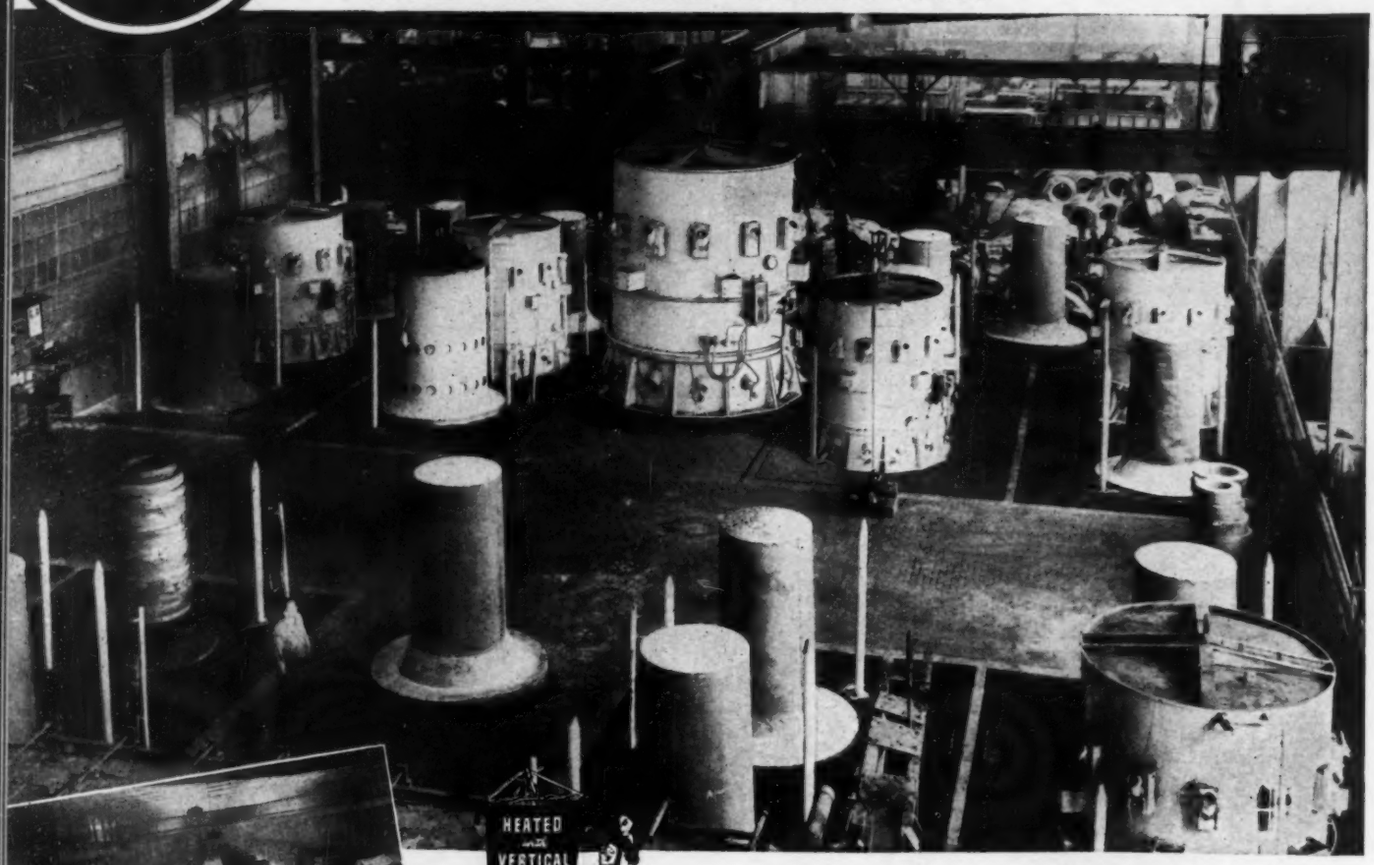
STEAM TURBINE COMPANY · TRENTON 2, NEW JERSEY

SALES OFFICES: ATLANTA • BOSTON • CHARLOTTE • CHICAGO • CLEVELAND • DENVER DETROIT • DULUTH • EDMONTON • GREAT FALLS • HAVANA • HELENA • HOUSTON KANSAS CITY • LOS ANGELES • MONTREAL NEW ORLEANS • NEW YORK • PHILADELPHIA PITTSBURGH • ROCHESTER • ST. PAUL • SALT LAKE CITY • SAN FRANCISCO • SEATTLE TORONTO • TULSA • VANCOUVER • WASHINGTON, D. C. • WINNIPEG

WILSON BELL TYPE FURNACES for COILED STRIP ANNEALING

CYLINDRICAL AND RECTANGULAR TYPES WITH VERTICAL RADIANT TUBES

- TIN PLATE COILS
- SHEET COILS
- STRIP COILS



The Standard Lee Wilson bell type furnace with vertical radiant tube heat application still offers the most uniform temperature distribution, the most uniform annealing with lowest production and maintenance costs.

The Wilson Annealing Unit is covered by Patents Nos. 1,952,402, 2,068,477, 2,078,356, 2,081,612, 2,089,843 and other patents pending.

ENGINEERED AND CONSTRUCTED BY THE

Lee Wilson ENGINEERING Co., Inc.

20005 West Lake Road CLEVELAND, OHIO

Telephone ACademy 4670

Sold by The WEAN ENGINEERING CO., Inc., Warren, Ohio

INDUSTRIAL FURNACES ★ RADIANT TUBE HEATING ★ HEAT TREATING PROCESSES

When you modernize...

USE A GEARMOTOR

W.P.B. indicates that we'll all be pushing war production for many months. And then the heat goes on reconversion.

Much of your equipment, running at peak load since 1941, probably needs to be replaced or modernized. Whichever you need . . . replacement or modernization . . . use a gearmotor when the drive requires speed reduction. Here's why.

A gearmotor is the most efficient means of speed reduction available today. It's more compact . . . lasts longer with less maintenance . . . is easier to install . . . lower in over-all cost . . . and safer for your employees. These advantages are not idle claims . . . for they've been proved in actual industrial installations.

Westinghouse offers a complete line of gearmotors for any speed reduction application from 1 to 75 hp. Each unit is specifically designed to conform to industry-wide A.G.M.A. standards. Each new unit contains many improved exclusive design features. Call your nearest Westinghouse office for details. Westinghouse Electric & Manufacturing Company, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-07227

WESTINGHOUSE

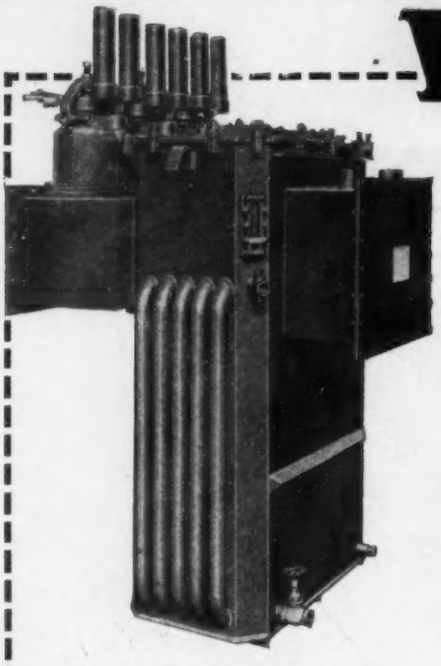
Westinghouse Gearmotors

PLANTS IN 25 CITIES . OFFICES EVERYWHERE

Four out of five drives need speed reduction

Wagner

can furnish a modern INDUSTRIAL-TYPE TRANSFORMER *for every Power need*

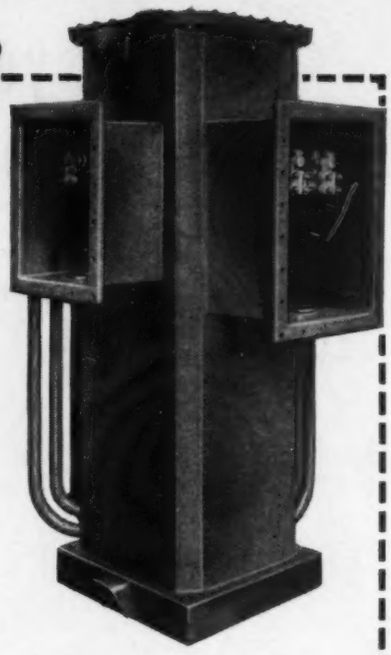


200-kva, 2400- to 480-volt Noflamol transformer with industrial-type terminal chambers for both high- and low-voltage connections.

No matter what your industrial transformer problem may be, Wagner has a modern industrial-type transformer to solve it. Air-cooled transformers can be installed to advantage for stepping down higher power-circuit voltage to allow connections of low-voltage appliances and machinery to the power circuit; for boosting voltage for small motors; and for phase changing.

Oil-filled, self-cooled transformers handle the largest loads with economy and efficiency. Noflamol transformers fill the need of a transformer containing a cooling and insulating liquid that retains the desirable characteristics of regular transformer oil but is noninflammable, thus giving safe dependable service installed in locations where regular oil-filled transformers would constitute a fire hazard.

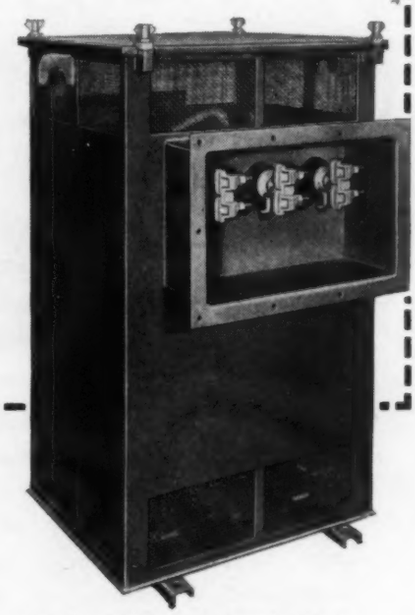
These are, of course, only a few advantages of Wagner's complete line of transformers. Contact the nearest Wagner branch for consultation on transformer problems for your individual plant.



A 150-kva, 3-phase, 60-cycle, 2400/4160Y- to 120/208Y-volt transformer equipped with a gang-operated G & W oil-fuse cutout on the high-voltage side and a low-voltage industrial-type terminal chamber.

Air-cooled transformer showing typical construction used for type AC, 10-kva and below, and type AA units through 25-kva.

This design provides a built-in junction box with removable coverplate, and knockouts on sides and bottom for conduit or open wiring. Jumpproof hanger lugs facilitate installation which can be indoors or outdoors.



100-kva, single-phase, 60-cycle, 480- to 120/240-volt type AC air-cooled transformer. Fabricated sheet-steel case designed for indoor service only.

These Bulletins are Yours for the asking!

You should have the comprehensive transformer information available in Bulletins TU-180 (Distribution), TU-181 (Power), and TU-33 (Noflamol). Also ask for GU-82 on the complete line of Wagner products. Write for them today.

TRANSFORMERS are but one of several **WAGNER PRODUCTS** serving industry.

Other **WAGNER PRODUCTS:**

AIR BRAKES
•
BRAKE LINING
•
HYDRAULIC BRAKES
•
INDUSTRIAL BRAKES
•
INDUSTRIAL BRAKE CONTROLS
•
TACHOGRAPH (Recording Speedometer)
•
ELECTRIC MOTORS

There is a Wagner Branch near you

Wagner maintains branches in 29 principal cities. These branches are manned by trained field engineers who will gladly work with you and show you how you can benefit by installing Wagner transformers.

ARMY (E) NAVY — NATIONAL SECURITY AWARD

T45-9

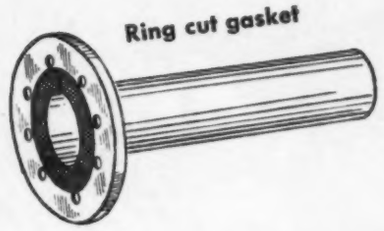
Wagner Electric Corporation

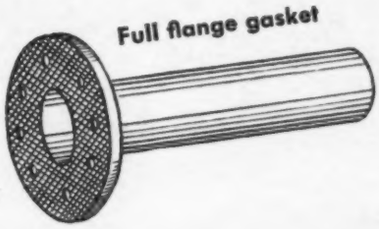
ESTABLISHED 1891

6483 Plymouth Avenue, St. Louis 14, Mo., U. S. A.

ELECTRICAL AND AUTOMOTIVE PRODUCTS

How to Seal Pipe Flanges...





A *ring cut* gasket, properly applied, does a better job than a *full flange* gasket. Here are a few hints that will help:

1. Make sure flanges are perfectly clean and true.

2. Use as thin a gasket as possible for the particular flange condition. (The rougher the flange surfaces, the thicker the gasket needed.)

3. See that the gasket is properly centered and does not project inside the flanges.

4. Pull up the flanges evenly and tightly, alternating from side to side to insure even pressure all around.

...and here's the Packing to do the job.

● You won't have to worry about pipe flanges if you seal them with J-M Service Sheet!

This has been proved by thousands of users over many years. That's why Service Sheet is today recognized as the No. 1 sheet packing for high pressure and high temperature conditions against super-heated steam, air, gas, water, hot oil, ammonia, acids, chemicals and many other fluids and gases.

To meet the increasingly severe demands of industry, Service Sheet has been constantly improved. Its dependability and high degree of uniformity are the result of quality and special manufacturing techniques developed in over 75 years of experience in the production of packings.

For further information about Service Sheet and other J-M Packings to meet specialized conditions, write Johns-Manville, 22 East 40th Street, New York 16, New York.

Johns-Manville

PACKINGS & GASKETS

THERE'S A DISTRIBUTOR NEAR YOU

V

BUILT IN PRODUCTION ABILITY—

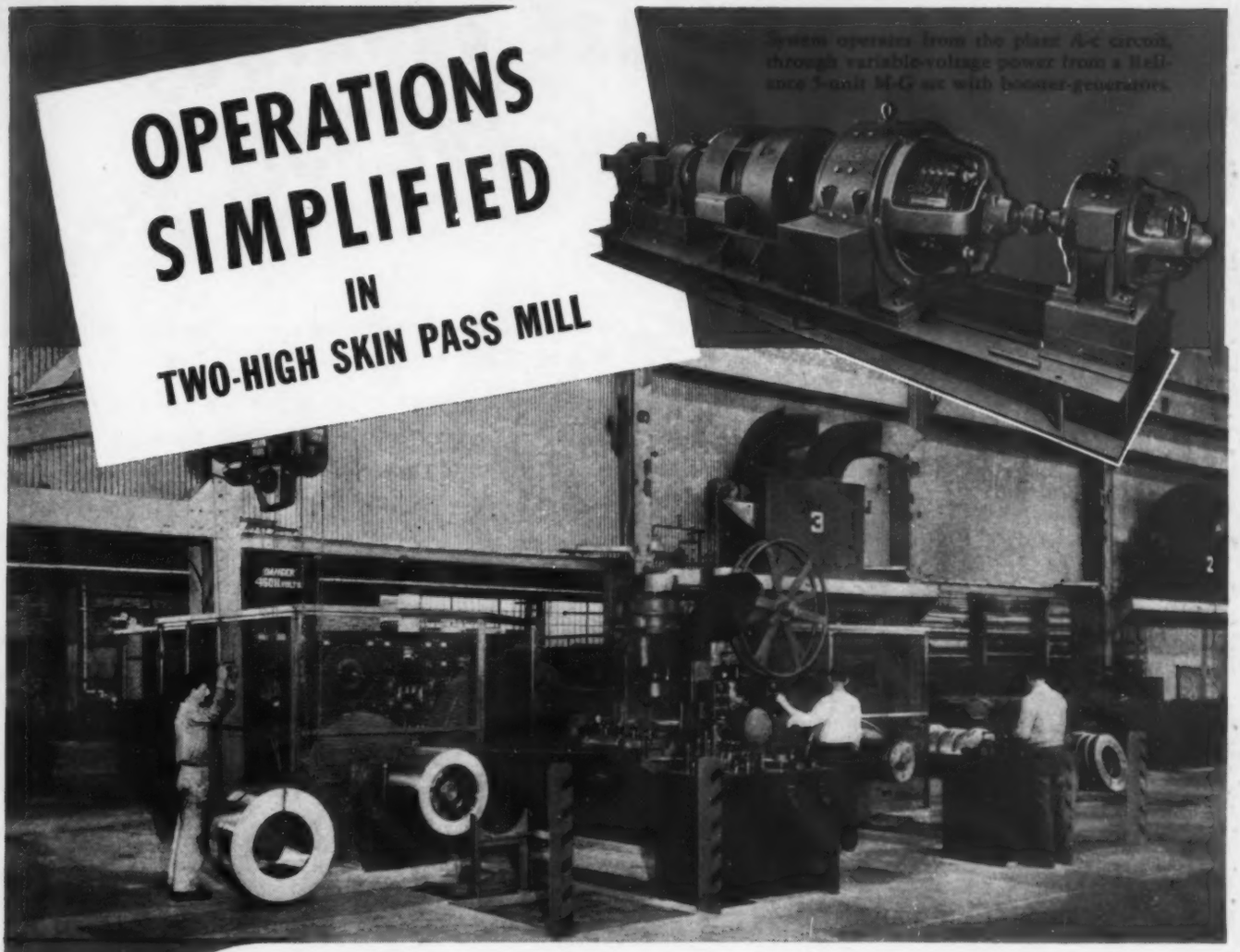
characteristic of all **vaughn** wire drawing equipment.

The Vaughn Machinery Company

Cuyahoga Falls, Ohio

COMPLETE COLD DRAWING EQUIPMENT
Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys.

OPERATIONS SIMPLIFIED IN TWO-HIGH SKIN PASS MILL



System operates from the plant A-c circuit, through variable-voltage power from a Reliance 5-unit M-G set with booster-generators.

Constantly controlled tension under all conditions, vital to satisfactory results in handling coiled steel, is obtained automatically in this mill by means of Reliance Motor-drive with all-electric, centralized control.

The uncoiler is kept under proper tension during all speed changes, and during the progressing reduction in coil diameter. At the same time, delivery tension is maintained as the coil increases on the recoiler.

In ease and simplicity of operation, improved quality as well as quantity of production, this application of Reliance Motor-drive has more than paid its way in comparison to former methods. If you would like to investigate the many possibilities of all-electric control, why not talk with a Reliance application engineer?

RELIANCE ELECTRIC & ENGINEERING COMPANY

1084 Ivanhoe Road • Cleveland 10, Ohio

Birmingham • Boston • Buffalo • Chicago • Cincinnati • Detroit • Greenville (S. C.) • Houston • Kalamazoo • Los Angeles • Minneapolis
New York • Philadelphia • Pittsburgh • Portland (Ore.) • St. Louis • San Francisco • Syracuse • Washington, D. C. • and other principal cities

M. J. E.

RELIANCE A-C D-C MOTORS

"Motor-Drive is More Than Power"

N·B·M #200 BRONZE BEARINGS CUT OPERATING COSTS—NOT ROLL NECKS

Here is a scene you will rarely see after you install new N-B-M #200 Bronze Bearings.

Longer intervals between roll changes are just one of many advantages. They also assure increased tonnage of more uniform gauge and big savings in maintenance. For instance:

In a typical 36" plate mill—pump lubricated breakdown stand—N-B-M #200 Bronze Bearings are giving 12 times the life of conventional babbitted shell bearings. One pair of bottom bearings alone has saved $500.00 in labor for bearing changes.

That is a rough idea of what our engineers can do for you. May we send one soon?

N·B·M BRONZE AND COPPER CASTINGS

Blast Furnace Copper Castings • Roll Neck Bearings • Slippers Housing Nuts • Machinery Castings • Acid Resisting Castings Phosphorized Copper • Babbitt Metals.

NBM

NATIONAL BEARING

DIVISION

PITTSBURGH • NEW YORK

AMERICAN Brake Shoe COMPANY

PLANTS IN: ST. LOUIS, MO. • PITTSBURGH, PA. • MEADVILLE, PA. • JERSEY CITY, N. J. • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO ILL.

"UNIVAN"

That Tough Steel

BUILT TO STAND UP UNDER SHOCK!

Right on the button—but no knock-out.

Like a "UNIVAN" casting, he's built to absorb frequent shocks without fatigue or breakdown. Its fine-grained Nickel-Vanadium steel structure makes "UNIVAN" the undisputed light heavyweight champion of alloy castings.

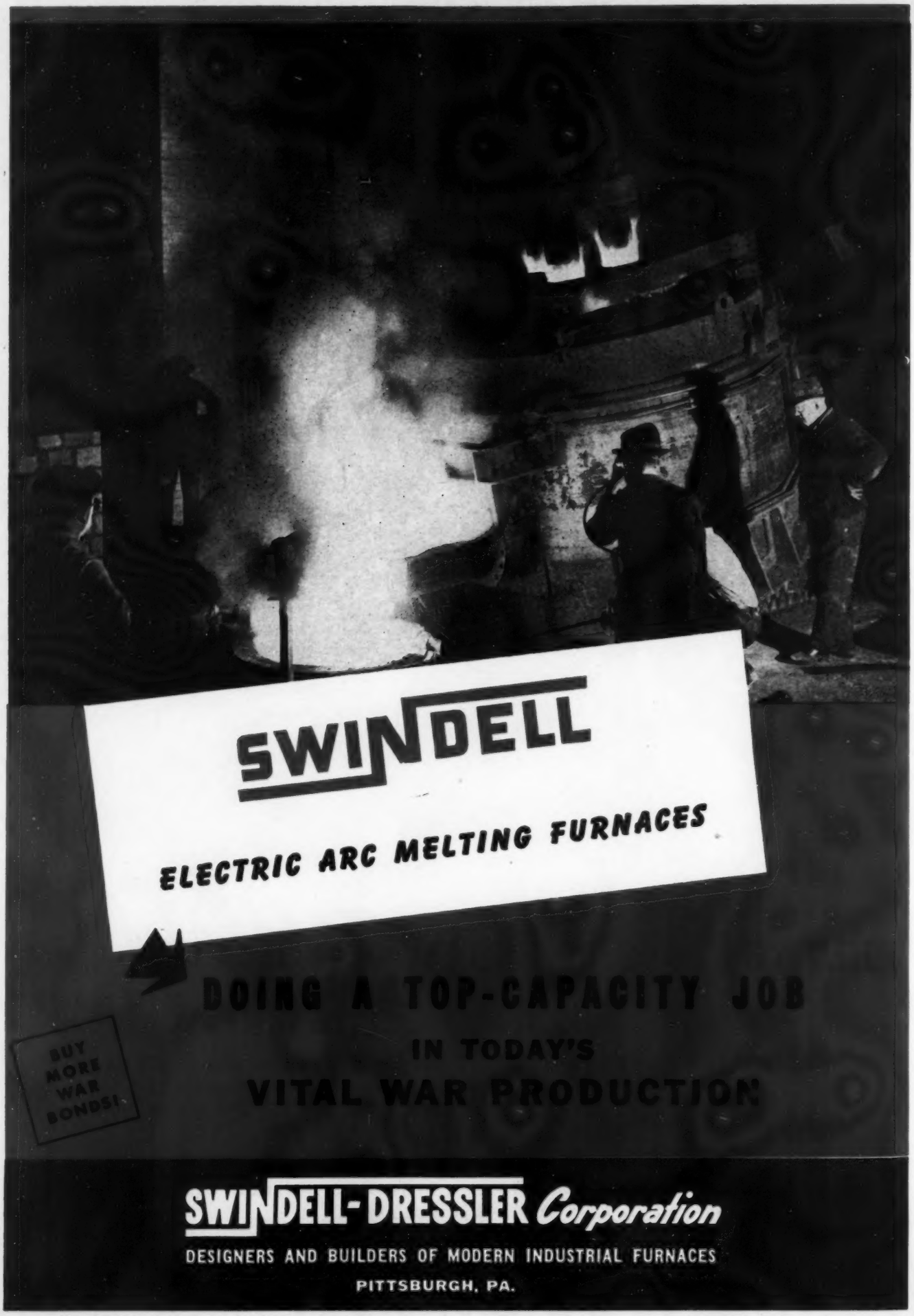
For ordinary jobs, ordinary steel will suffice, but when the casting is subject to severe stresses, vibration and shock, specify "UNIVAN"—that tough steel.

ARMY E NAVY

UNION STEEL CASTINGS

DIVISION OF
BLAW-KNOX CO.
PITTSBURGH, PA.

MAKERS OF Driving Wheel Centers, Locomotive Frames, Pump Casings, Vault Doors and Frames, Annealing Boxes, Spindles, Coupling Boxes, Open Hearth Charging Boxes, Gear Blanks — and other Castings for Steel Mills and General Industry.


SWINDELL
ELECTRIC ARC MELTING FURNACES
DOING A TOP-CAPACITY JOB
IN TODAY'S
VITAL WAR PRODUCTION
BUY MORE WAR BONDS!
SWINDELL-DRESSLER Corporation
DESIGNERS AND BUILDERS OF MODERN INDUSTRIAL FURNACES
PITTSBURGH, PA.

Symbols of Electro-Technical Products Research

Manufacturers of resinous coated electrical insulation fabrics and papers for the production and maintenance of industrial motive power equipment

ELECTRO-TECHNICAL PRODUCTS, INC.

ELECTRICAL INSULATION DIVISION

115 CENTER STREET, NUTLEY 10, NEW JERSEY

Branch Factories: LETCHWORTH, ENGLAND • LOS ANGELES, CALIFORNIA

Iron and Steel Engineer, April, 1945

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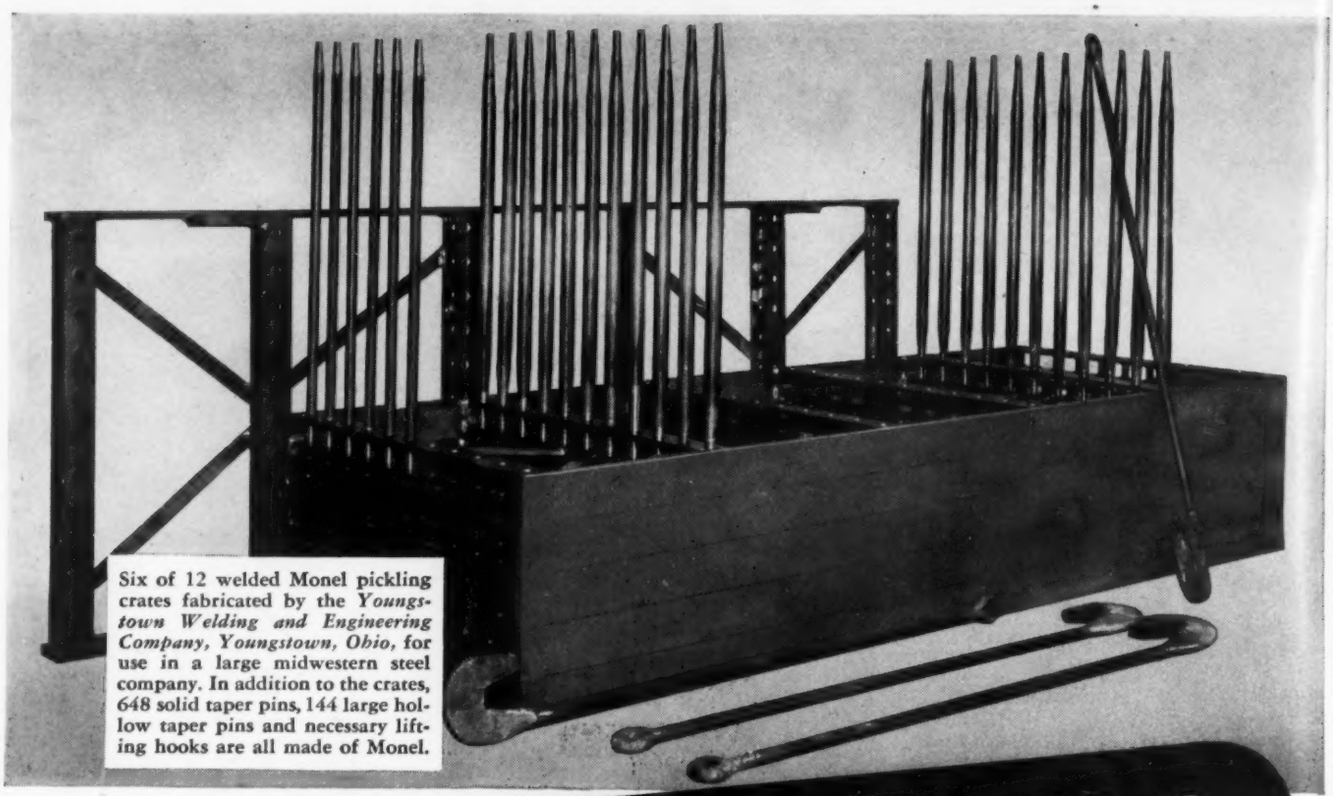


Six of 12 welded Monel pickling crates fabricated by the *Youngstown Welding and Engineering Company, Youngstown, Ohio,* for use in a large midwestern steel company. In addition to the crates, 648 solid taper pins, 144 large hollow taper pins and necessary lifting hooks are all made of Monel.

How much DEAD weight are YOU pickling?

Steel mill eliminates half ton of useless weight; speeds output and cuts costs

In the mill where this photo was taken, pickling crates once weighed 1550 pounds.

Then the mill switched to Monel... cut weight to 550 pounds... handled a *bigger* load!

Not only are the new crates 63% lighter, they're *stronger,* too. With less *crate* to haul around, there's room for more *payload*... and less waste of time and labor, power and acid.

With Monel equipment, excess weight is eliminated... safely. Pickling acids in common use by steel mills have little effect on this corrosion resistant metal. Accordingly, there's no need to allow for loss of strength because of rapid corrosion.

In addition to that high degree of corrosion resistance, Monel's toughness and ductility enable it to take plenty of hard knocks and rough handling. In pickle rooms where the average crate would be completely shot in a few years' time, Monel equipment is still strong and serviceable.

Because Monel is readily formed and welded, it's easy to build a crate that *exactly* fits your needs. Monel is available in bar, flats, rounds and angles... and as wire, screen and wire cloth.

Whether you measure your loads in pounds, or tons... whether you're pickling steel sheet or heavy castings, tiny screw machine products or steel stampings... you can't do better than to *specify Monel for your equipment.*

MONEL

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK 5, N. Y.

NICKEL (INCO) ALLOYS

MONEL • "K" MONEL • "S" MONEL • "R" MONEL • "KR" MONEL • INCONEL • "Z" NICKEL • NICKEL

Sheet..Strip..Rod..Tubing..Wire..Castings..Welding Rods (Gas and Electric)

Designed and built to provide constant oil flow to burners regardless of varying line pressure the Bloom Differential Oil Flow Control Valve is used for reversing furnaces, open hearth furnaces, side door and other heating furnaces.

With this valve, oil flow is directly proportional to valve position, and the valve has a calibrated flow dial with definite flow for each graduation. Even with upstream pressure constantly changing, uniform flow is obtained because the Bloom Control Valve automatically maintains a constant differential pressure across the valve. It is fast acting, and never "overshoots" at reversals.

The flow chart illustrated above is typical of the results obtainable without special attention or effort. The valve is entirely automatic—you can install it and forget it.

Write for Bulletin 2050

BLOOM *ENGINEERING COMPANY*
857 W. NORTH AVENUE
PITTSBURGH 12, PENNSYLVANIA

UNITED

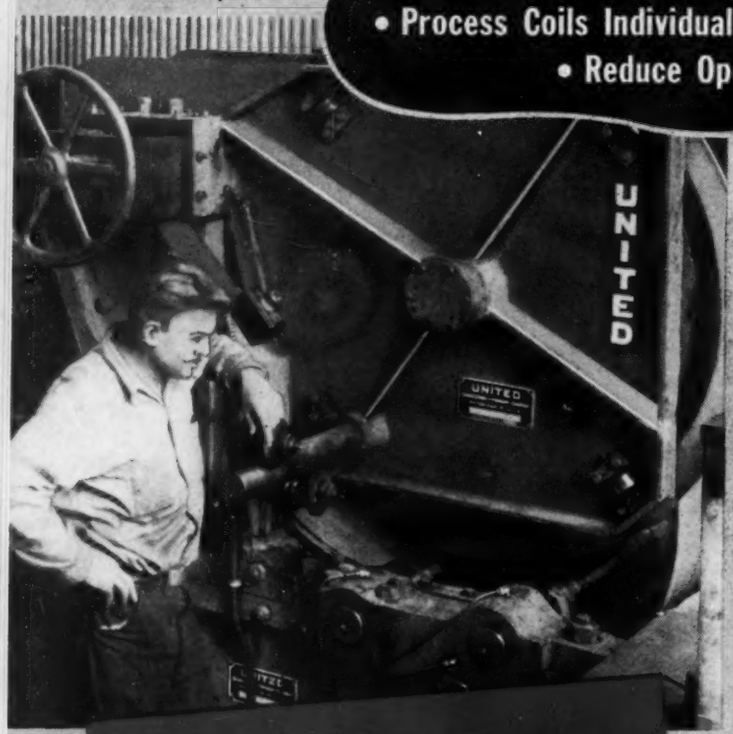
Semi-Continuous Strip Picklers

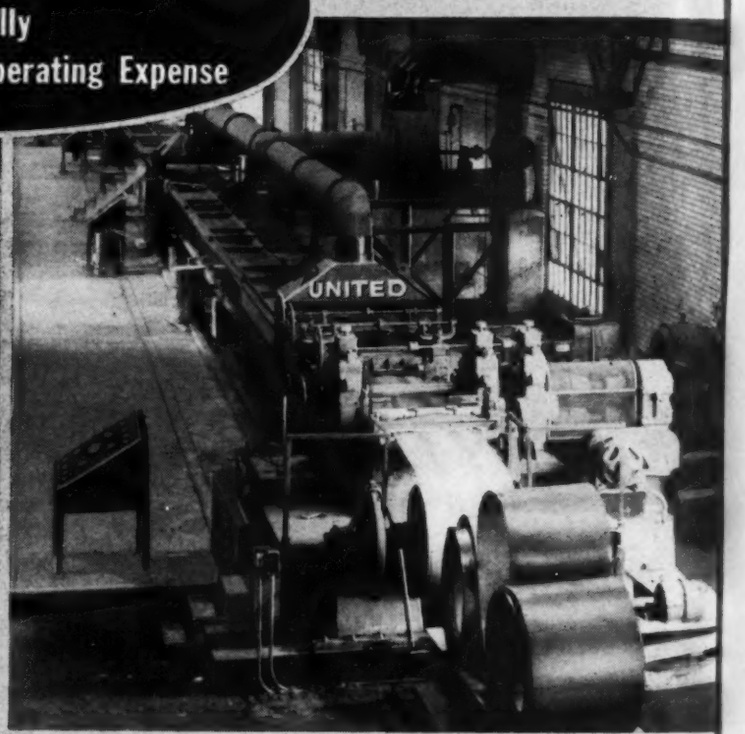
(PATENTED)

UNITED SEMI-CONTINUOUS STRIP PICKLERS are recommended for satisfactory low-cost-per-ton pickling of hot rolled strip, particularly to producers having medium tonnage requirements. Lower installation costs, and saving in space required, are effected by elimination of welders or stitchers for joining, looping pits, and shears for parting, since coils are individually pickled. In comparison to conventional **tub pickling practice,** substantial reduction in operating cost is realized and production of **uniformly high quality** pickled strip is assured.

- Cost Less to Install
- Require Minimum Plant Area
- Process Coils Individually
- Reduce Operating Expense

Delivery end of UNITED Semi-Continuous Strip Pickler





UNITED 38" Semi-Continuous Strip Pickler

Another United First in the Development of New and Better Equipment for the Iron and Steel Industry

Existing designs of UNITED SEMI-CONTINUOUS STRIP PICKLERS may be adapted to suit individual requirements of space, tonnage and other modifying factors. The availability of war expanded manufacturing facilities makes this an opportune time to consult our engineers concerning your present and post-war requirements.

UNITED ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

Plants at PITTSBURGH · VANDERGRIFT · NEW CASTLE · YOUNGSTOWN · CANTON
Davy and United Engineering Company, Ltd., Sheffield, England
Dominion Engineering Works, Ltd., Montreal, P.Q. Canada
Adamson United Company, Akron, Ohio

UE&FCO

Reg. T. M.

The World's Largest Designers and Makers of Rolls and Rolling Mill Equipment

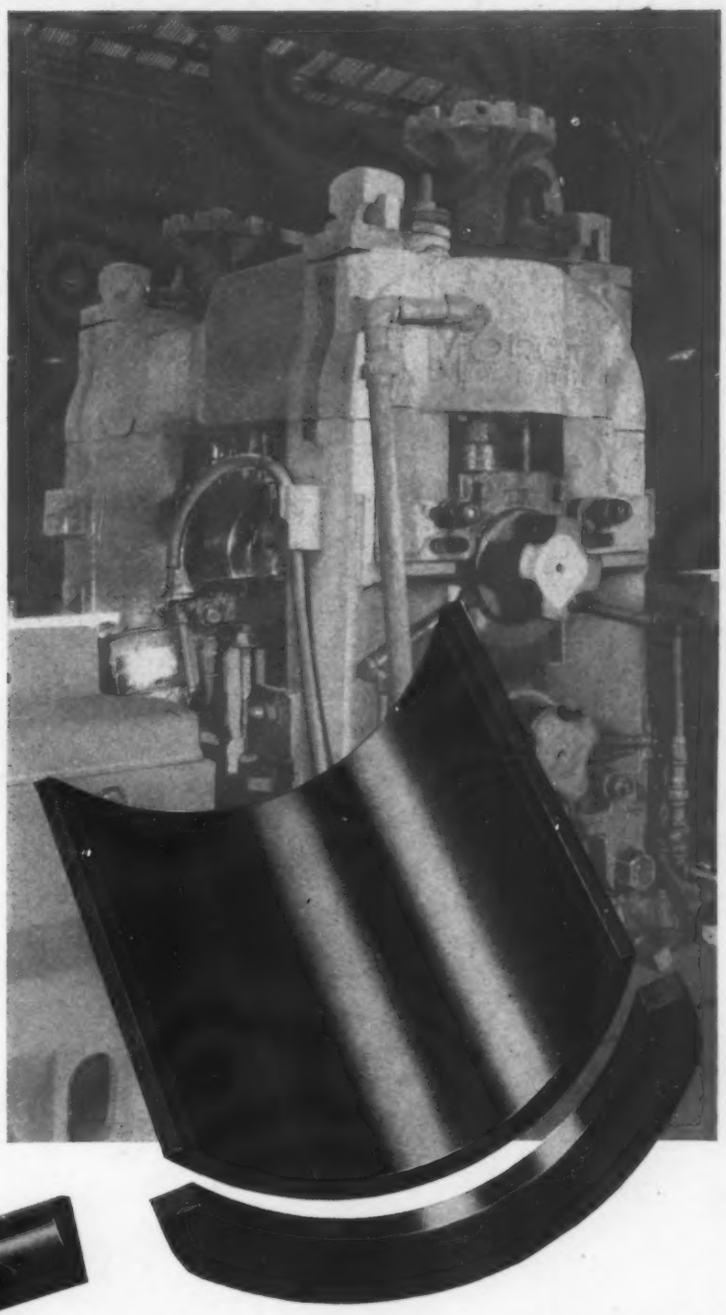
High bearing capacity — Lowered power costs

A-B-K Laminated Plastic Bearings

DEVELOPED by A-B-K engineers to provide an unusually low coefficient of friction, A-B-K Laminated Plastic Roll Neck Bearings have shown extensive savings in power consumption when used in merchant, rod, blooming and other steel mill operations.

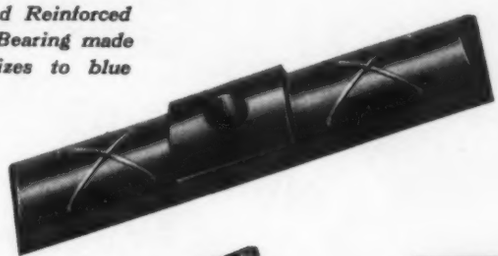
A-B-K bearings have made increased production records up to 20 times the tonnage as compared with metal bearings.

The same research and engineering facilities that provided these dependable bearings are available for your problem. Write, wire or phone, American Brakeblok Division, 4600 Merritt Ave., Detroit 9, Mich.



A-B-K Laminated Plastic Roll Neck Bearing with separate thrust collar.

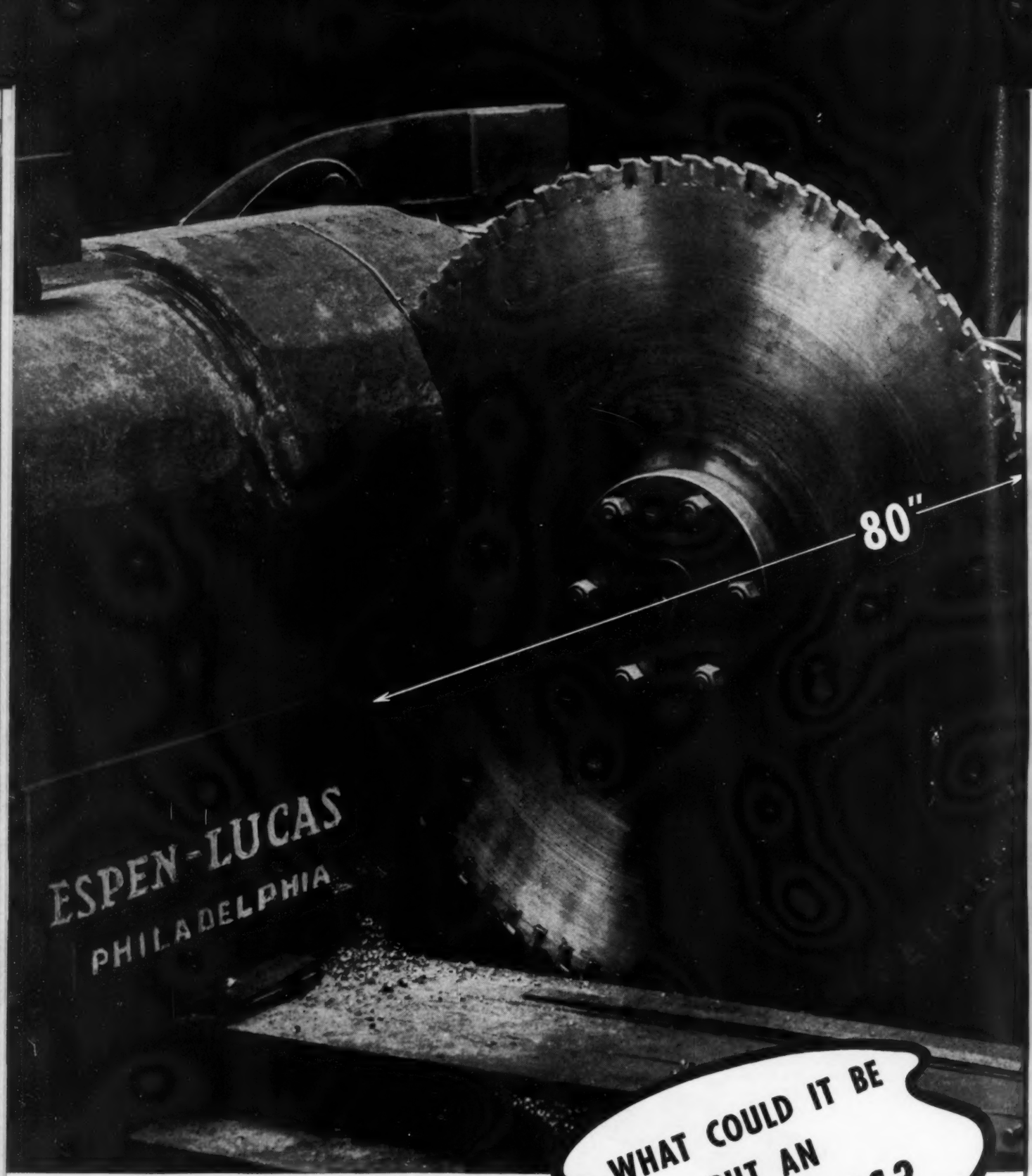
A-B-K Patented Reinforced Edge Slipper Bearing made in required sizes to blue prints.



Phantom view of A-B-K Patented Reinforced Edge Slipper Bearing.

American Brakeblok

DIVISION OF AMERICAN Brake Shoe COMPANY



WHAT COULD IT BE BUT AN ESPEN-LUCAS?

The work is large—a forging 45" in diameter. The metal hard—Chrome Nickel Molybdenum. But the ESPEN-LUCAS cold saw cutting-off machine is built for exactly such jobs. It has the rigidity for straight cutting, with no vibration. It has the speed that puts this type of heavy duty sawing work on a real production basis. Among the more than 100 types of cold saw cutting-off machines built by Espen-Lucas you will find one or more to fill your particular needs. Send us details of your requirements for quotation. Espen-Lucas Machine Works, Front Street and Girard Avenue, Philadelphia 23, Penna.

★ ★ ★ **ESPEN-LUCAS**

COLD SAWING MACHINES • ROTARY PLANERS
COLUMN FACERS • SPECIAL MACHINERY

Try this "PRESCRIPTION" in your Pinion Stand!

SEE THOSE heavy-duty gears inside the pinion stand pictured above? That's a spot in your mill where heavy, shock loads impose tremendous pressures on your lubricant.

Between these meshing teeth, the lubricant is squeezed so thin you can't see it with the naked eye. This means "boundary lubrication," with only microscopically thin films to protect the meshing gear teeth, prevent excessive friction, heat and wear.

To perform this difficult job, Socony-Vacuum has developed special prescription lubricants — Gargoyle Compounds. These Compounds form strong, tenacious films that *bond* to the metal to resist the rubbing, squeezing action of heavily loaded teeth.

Just as important, Gargoyle Compounds are highly stable. In circulation systems like this, where they are used over and over again, they resist deterioration and assure low oil consumption.

Try Gargoyle Compounds for longer gear life, greater efficiency.

SOCONY-VACUUM OIL CO., INC.
Standard Oil of N. Y. Div. • White Star Div. • Lubrite Div. • Chicago Div. • White Eagle Div. • Wadhams Div. • Magnolia Petroleum Company • General Petroleum Corporation of California.

GARGOYLE Lubricants

SOCONY-VACUUM'S 5 Steps to Lower Production Costs:

1. Lubrication Study of Your Entire Plant
2. Lubrication Schedules and Controls
3. Lubricant Storage and Handling System
4. Skilled Engineering Counsel
5. Progress Reports of Benefits Secured

TUNE IN "INFORMATION PLEASE"—MONDAY EVENINGS, 9:30 E.W.T.—NBC

You are looking at

A CUTAWAY VIEW OF A NEW TREND

in motor design

Two decades ago the purchaser of squirrel-cage motors had but one choice—the open motor. If operating conditions proved too severe, the only answer was to be found in frequent replacements.

Then came a period of new development in mechanical design, which resulted in the birth of dripproof, splashproof, totally-enclosed, fan-cooled, and a host of other new types, each designed for operation under certain adverse conditions.

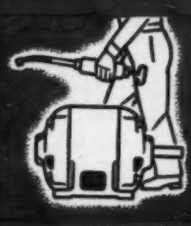
But today there is a new trend—represented by Crocker-Wheeler Protected-Type Motors. These motors, besides having the surplus capacity of open designs, provide protection against many of the most common hazards encountered in operation. They may be used for many services for which enclosed and partially-enclosed motors have been specified in the past, *and yet, Protected-Type Motors cost no more than open motors.*

When and Where to Use Protected-Type Motors

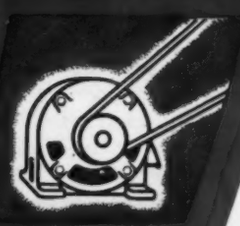
WHERE THERE IS DRIPPING LIQUID
Because Protected-Type Motors are dripproof; falling water, oil, or other liquids cannot enter the windings. All ventilating openings are shielded.

WHERE THERE ARE FALLING CHIPS
Protected-Type Motors are ideal for machine tool and similar applications where metal chips and other foreign matter might injure the windings of less well-protected motors.

WHEN INSPECTION VISITS ARE FEW AND FAR BETWEEN
Because rotors are practically indestructible, stator windings are amply insulated, and ball bearings require attention only annually (sleeve bearings are optional), Protected-Type Motors call for minimum maintenance.



FOR ALL GENERAL-PURPOSE APPLICATIONS
Rated 40C rise, full-load continuous duty, with a 15 per cent service factor, these motors are suitable for all general-purpose applications. Mounting dimensions conform to N. E. M. A. standards.



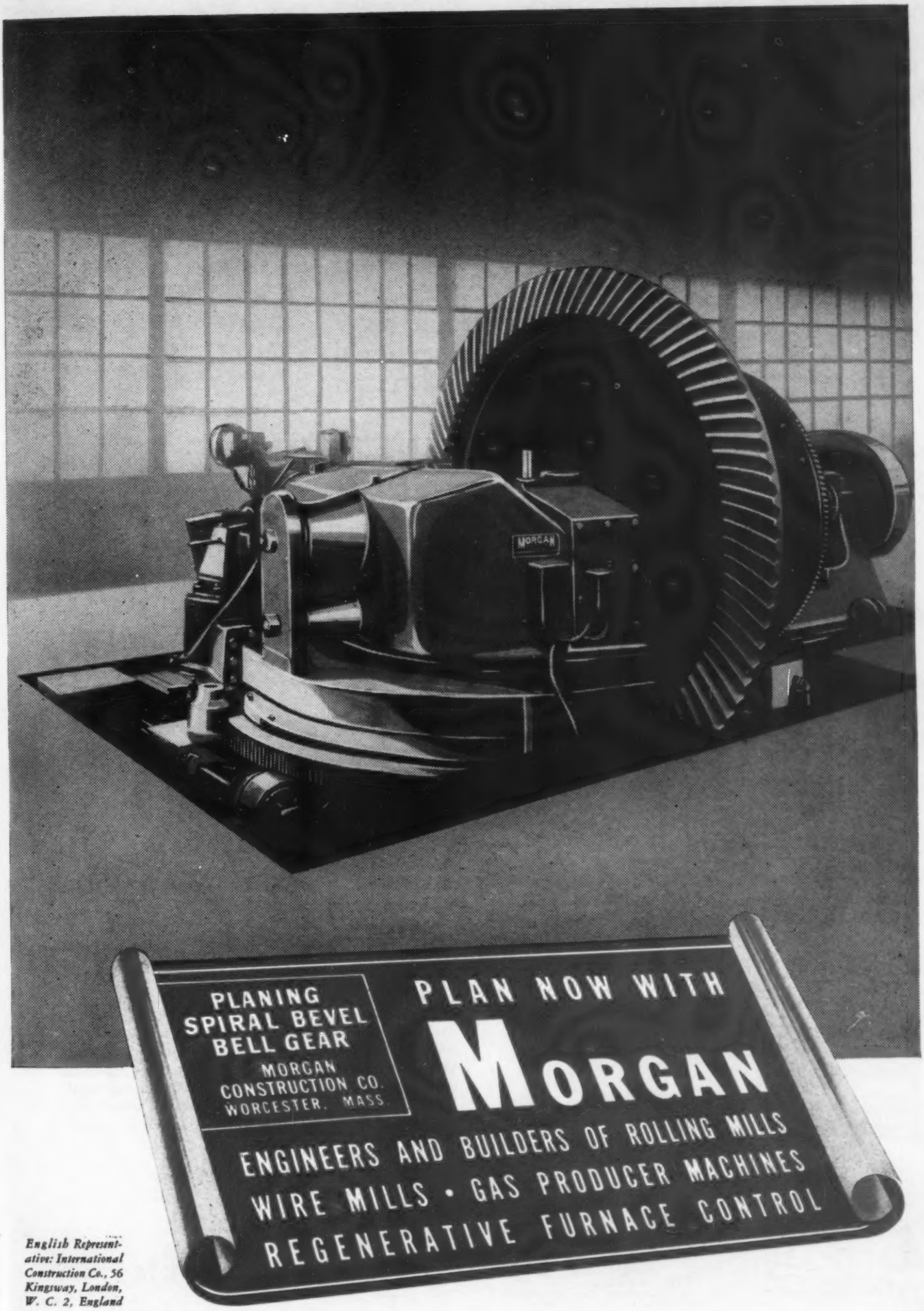
FOR COMPLETE DETAILS, send for your FREE copy of this NEW four-page bulletin. Shows how these motors are protected; why they will give long trouble-free service. Write today — no obligation.

CROCKER-WHEELER

A DIVISION OF JOSHUA HENDY IRON WORKS, AMPERE, NEW JERSEY

Branch Offices: BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • DETROIT • LOS ANGELES • NEW YORK • PHILADELPHIA • PITTSBURGH • SAN FRANCISCO • WASHINGTON

SQUIRREL CAGE MOTORS WOUND ROTOR MOTORS DIRECT CURRENT MOTORS GENERATORS FLEXIBLE COUPLINGS



English Representative: International Construction Co., 56 Kingsway, London, W. C. 2, England

ADVANTAGES..
in Design

1. Simple construction
   a. No tapes or braids
   b. No metallic coverings
2. Insulated by Strip Process
   a. Perfectly centered conductors
   b. Uniform thickness of Okolite insulation
   c. Uniform thickness of Okoprene covering
3. Vulcanized in a continuous metal mold
   a. Tough, dense covering
   b. Uniform vulcanization throughout length

ADVANTAGES..
in Operation

ELECTRICAL

Okolite Insulation

1. Ozone resistant
2. High dielectric strength
3. Stable electrical characteristics
4. Low specific inductive capacity
5. High current carrying capacity (75° C copper temperature)

Okoprene Covering

1. Additional dielectric strength
2. High surface resistance eliminates charging current drainage from surface of cable
3. Ozone resistant

PHYSICAL

1. No braids to rot
2. High moisture resistance
3. Resists oil and solvents
4. Resists acids, alkalies and corrosive chemicals
5. Non-flammable covering
6. Can be operated at 75° C
7. Unaffected by sunlight
8. Weatherproof
9. Long-lived

ADVANTAGES..
for Installation

1. No potheads required
2. Easy to splice
3. Light weight
4. Small outside diameter
5. Smooth, snag-proof covering
6. Easy to pull into ducts
7. High abrasion resistance
8. High tensile strength sheath
9. Flexible at low temperatures
10. No saturants to soften in heat or flake off in cold weather
11. Can be bent on small radius

get them all in one cable

OKOLITE-OKOPRENE

Because of its versatility and because of its low maintenance, OKOLITE-OKOPRENE* is an excellent electrical cable for all-around service. Engineers can specify it with confidence in its performance record, as millions of feet have been installed and have proved long-lived under widely differing conditions of operation. Among the fields in which these applications have been found widely useful are the various branches of the metal-producing industries.

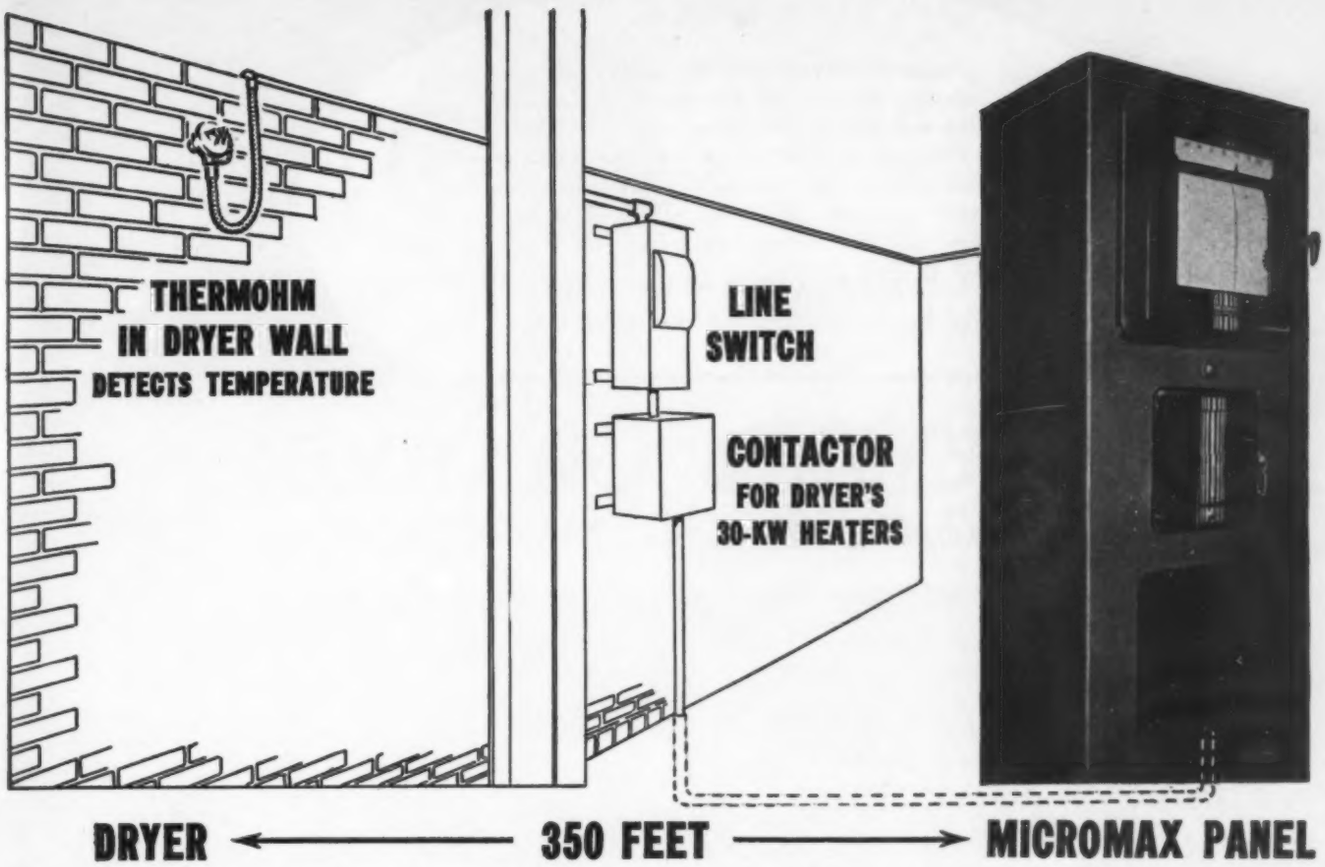
Install them in ducts . . . bury them directly in the earth . . . expose them to the elements, Okolite-Okoprene cables need no additional protection. Designed in all standard sizes and many colors for service up to 5000 volts, they are simple to handle, splice and terminate.

The principal advantages of Okolite-Okoprene cables are condensed above. Note that these include the electrical operating advantages of Okolite insulation and Okoprene covering. Bring your problems of electrical distribution to Okonite engineers. Pool your own experience with theirs for the best results in the selection of insulated wires and cables. The Okonite Company, Passaic, New Jersey.

*Patent No. 2,312,058

OKONITE OKONITE SINCE 1878 **insulated wires and cables**

4044



Arrangement of equipment in which a Micromax Controller automatically holds temperature to a preset program in a coke-products dryer at the Niagara Falls plant of International Graphite & Electrode Corp.

Dryer's Temperature Program Closely Regulated by MICROMAX CONTROLLER

The temperature program held by the above-pictured Micromax Controller can last as long as 30 days, and can be quite intricate or quite simple. The rate of temperature increase per day can be changed in large or small amounts, and any desired soaking temperature can be held as long as desired. The control is entirely automatic — the Micromax is preset for the complete cycle, and takes complete charge of switching electric power to the dryer's 30-kw heater. Because many war products require careful and accurate drying, International Graphite's solution of the temperature-control problem has wide application in industry.

A Micromax Controller, using a Thermohm (L&N electrical resistance-thermometer bulb) as its temperature detector, is ideal for this Program Control service, for a number of reasons:

1. The Thermohm is sensitive and accurate not only at the highest drying temperatures but also at the room temperature where the process starts.

2. The Thermohm is as sturdy as a thermocouple and, like a couple, can be replaced if ever necessary without any effect on the rest of the control system.

3. The Micromax Recording Controller can be as sensitive at 350 feet from the dryer as though it were 35 feet away; and it is connected to the Thermohm and the control relays only by ordinary electric cable.

4. Micromax is highly dependable on heavy-duty work. It is not only sensitive and accurate, but is strongly made and permanently adjusted to hold its dependability of operation. And it can be made for thermocouples or Rayotubes instead of Thermohms; with control to meet fully the needs of any controllable furnace or dryer. An L&N engineer will either help apply Micromax to a specific problem, or send the appropriate catalog, as you prefer.

Jrl Ad N-33C(4)

depends on me!
A Slogan For Every American

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.
LEEDS & NORTHRUP
MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Steel production at 95–100% capacity has meant 24-hour-a-day operation of hundreds of Cleveland Cranes in many mills for several years.

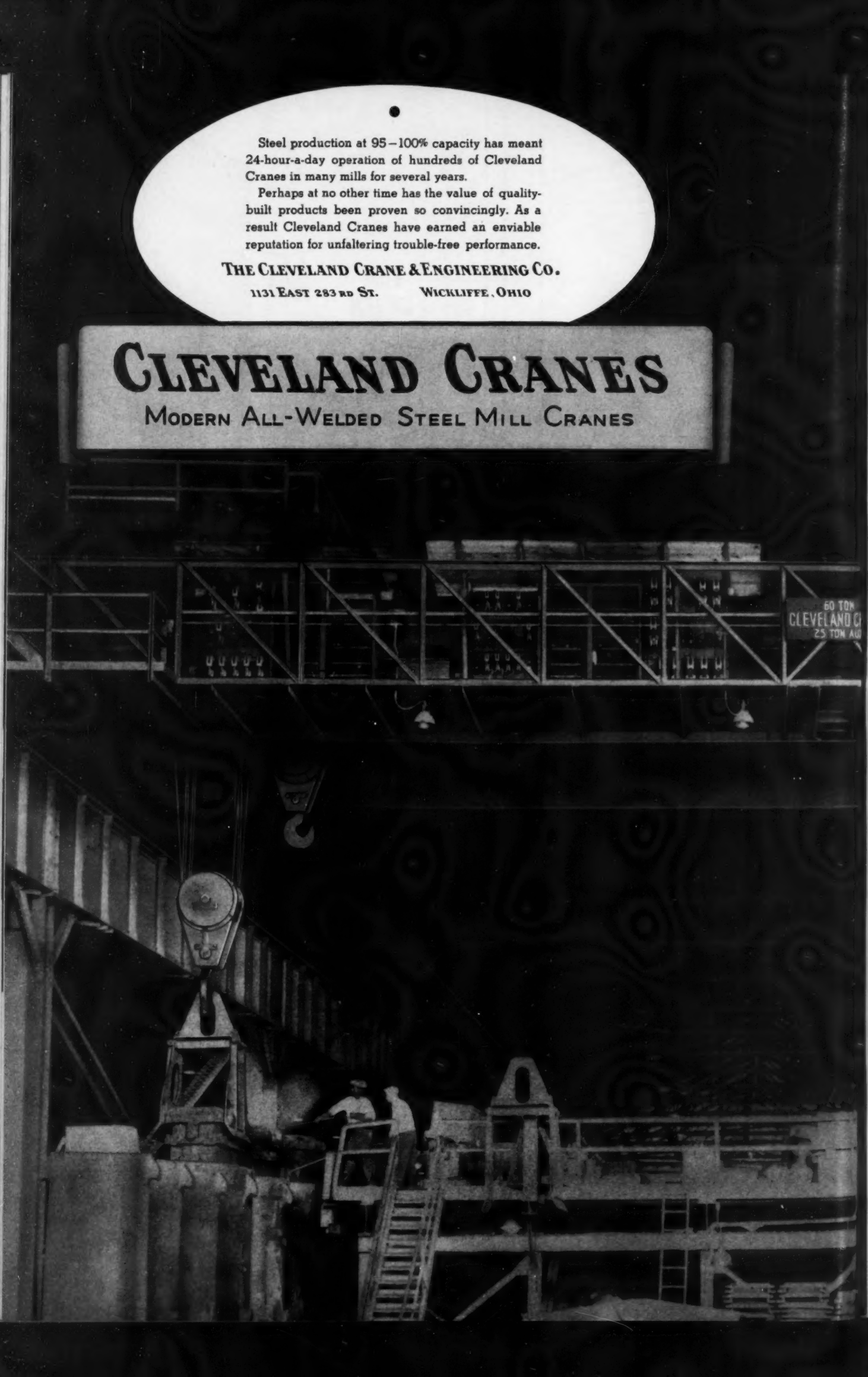
Perhaps at no other time has the value of quality-built products been proven so convincingly. As a result Cleveland Cranes have earned an enviable reputation for unfaltering trouble-free performance.

THE CLEVELAND CRANE & ENGINEERING CO.

1131 EAST 283 RD ST. WICKLIFFE, OHIO

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES



Crops and Shorts

THE steel industry is beginning to regain its production rate after the blows dealt it by weather, fuel shortages and manpower. Nature took care of the first item and to some extent, the second. Manpower continues to be short and may grow worse. It is estimated that the industry needs 50,000-60,000 more men to fill present shortages and to meet future selective service requirements — and this is not an imaginary bugaboo. Production units are actually idle. Tonnage has been lost and more is threatened.

▲

WPB has relaxed to the point of permitting the use of some metal swivel irons in office chairs. That ought to prevent a breakdown of our desk-top strategy.

▲

OPERATION of a loaded vehicle on power supplied by high frequency current picked up from wires laid underground is reported in a Moscow factory.

▲

ALL you have to do to borrow money from a banker is prove you don't need it — and anytime you think your credit is no good, try borrowing trouble.

▲

A STUDY of the proposal for a guaranteed annual wage, made by one steel company, showed that if a full force and maximum production had been maintained throughout 1937, costs would have exceeded receipts from customers by $582,000,000 and an excess inventory of 6,000,000 tons would have been on hand at year's end. If production had been curtailed to avoid the inventory, with workers paid while idle, costs would have exceeded receipts by $281,000,000. From this, the results of nationwide imposition of the proposal can well be foretold.

▲

A DISPATCH from Paris states that our G.I.s feel that they are being treated as children who don't understand. If our circulation included them, we would like to assure them that they shouldn't feel unique in this.

METALLURGISTS report that captured war material shows the Japs using an abundance of alloying metals, but with mediocre workmanship. German equipment shows definite shortages of some metals but consistently good workmanship.

▲

MAYBE the latest offensives in Europe won't end the war but at least they took the sense out of all those Oder and Cologne jokes which filled the papers and radio.

▲

PERHAPS few of our readers are feeling particularly wealthy, what with taxes, high prices, war funds, etc., but if you're tempted that way just remember that, based on the national average, your share of the federal debt is 1½ times your annual income, as compared to less than ¼ back in 1930 — and the debt limit is being raised to $300,000,000,000, with prospects for further increase in the future. Some authorities look for a federal debt of $400,000,000,000 by 1950.

▲

REMEMBER when you used to turn up your nose at all cigarettes except your pet brand?

▲

OBJECTIVES of the 12 o'clock curfew, as stated by J. F. Byrnes, were to save coal for heating and lighting, and to help in the fields of manpower, transportation and in other ways. Reports indicate the coal saving to be a "dud." We can report that it is now possible to find a taxi after midnight, but with the curfew on, who wants it? We can also report that the curfew is hard on the constitution. People think 12 o'clock is too early to go home, so they hunt "another place" and, when they find it, have to make up the time they lost hunting for it.

▲

UNSEASONABLY warm weather has resulted in an unusually early crop of backaches, blisters and similar spring ills, as victory gardeners broke out spades, rakes and hoes in the annual matching of wits with grubs, beetles, et al.

▲

THIS year brings the 100th anniversary of the birth of Wilhelm Roentgen, discoverer of X-rays, and the 50th anniversary of his discovery which has proved a great boon to medical science and, more recently, to industry.

▲

THE Kalends, house organ of Waverly Press in Baltimore, quotes some unknown genius as follows: "If a woman can make him either happy or unhappy, he is young. If she can make him happy but not unhappy, he is middle-aged. If she can make him neither happy nor unhappy, he is old."

▲

AS military successes begin to bring war's end in sight, many federal agencies which were established as temporary expedients to meet war conditions are digging in for postwar berths — and they'll probably be harder to root out than the Japs and Nazis that go underground.

Electrical Way to Get More Ingots

—WITH AN ALLIS-CHALMERS ARC FURNACE SUBSTATION

LOWERING OPERATION costs and boosting ingot output of arc furnaces is the aim of Allis-Chalmers in designing unit-responsibility substations — like the one illustrated below.

Elements featured in the drawing are quick-acting Regulex electrode control, and a low maintenance furnace switch for disconnect duty, coordinated through the operator's control with furnace transformer and control current transformers.

The sturdy disconnecting switch is expressly designed for repetitive arc furnace duty. Only slight maintenance is needed . . . contacts are long-lived.

Allis-Chalmers also supplies a low-maintenance air blast interrupter for service up to 22,000 volts.

Revolutionary Regulex control, shown below, pays dividends to operators by making possible extra "heats" per day . . . because it's faster-acting.

The Regulex set has no contactors to maintain. Its great amplifying characteristics and instant response to arc current and voltage eliminate power waste — and *all* with the ruggedness and reliability of standard rotating electrical machinery!

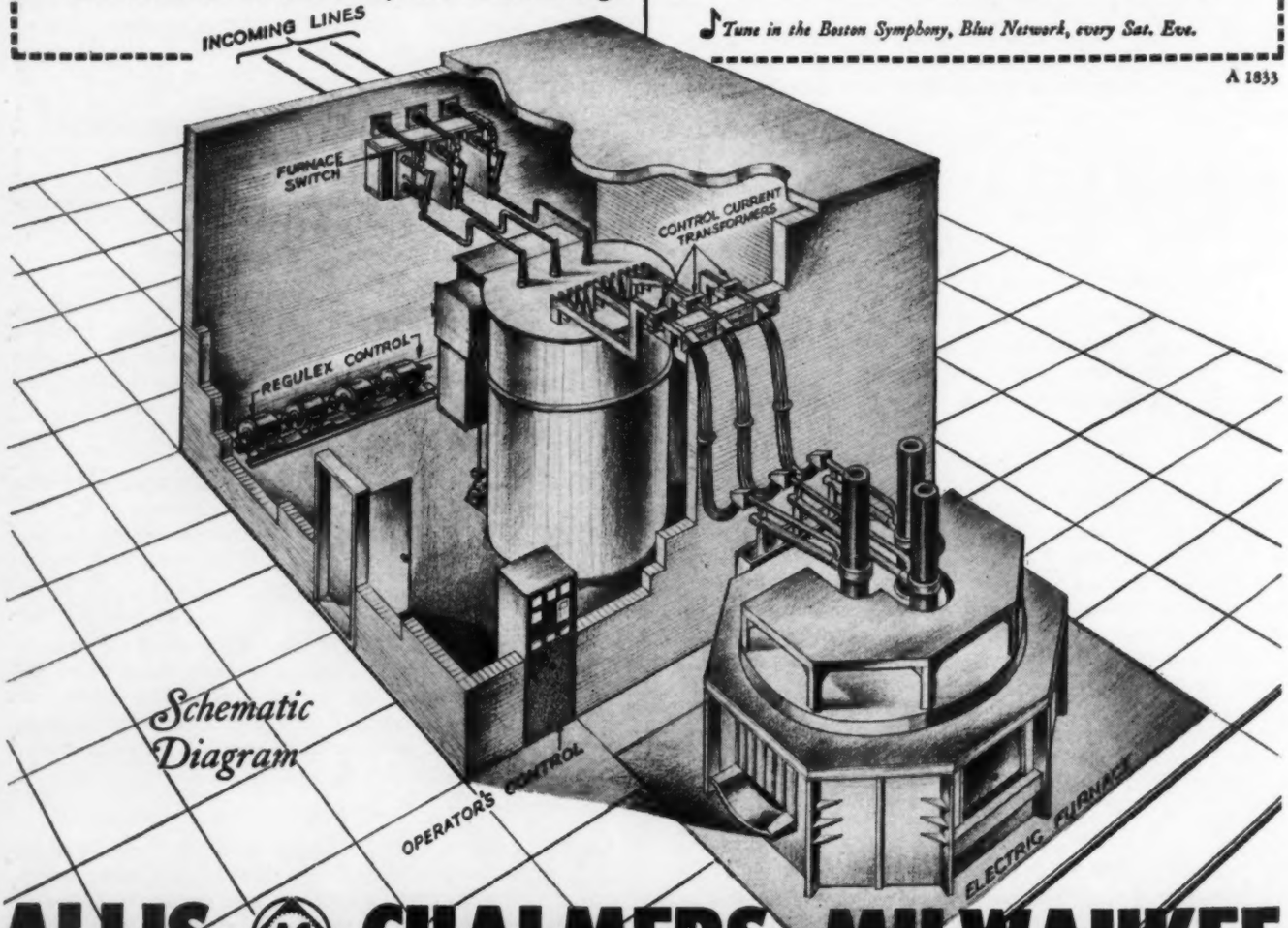
As added features, Regulex control can be equipped with flywheels which automatically raise electrodes when power fails, and an auxiliary generator, for making the control independent of a d-c shop source when desired.

Remember, Allis-Chalmers makes a complete line of furnace electrical equipment. There's undivided responsibility — no "buck-passing."

For complete information, call our district office. Or write direct to ALLIS-CHALMERS, MILWAUKEE 1, WIS.

♪ *Tune in the Boston Symphony, Blue Network, every Sat. Eve.*

A 1833

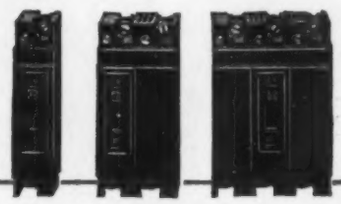


Schematic Diagram

ALLIS CHALMERS · MILWAUKEE

TRUMBULL "AT" CIRCUIT BREAKERS

ANYBODY CAN *STOP* TRAFFIC . . IT TAKES A TRAINED MAN TO KEEP IT *MOVING* . . .



One, Two and Three Pole Type "AT", 50 amp. frame Circuit Breaker Units.

Like the trained traffic cop, Trumbull "AT" circuit breakers automatically detect the threatened traffic block on your Electrical highways and take immediate action to prevent trouble. A thermal trip senses momentary overloads . . . and passes them on without interruption. Yet when heavy overloads or short circuits threaten, the multiple common trip-bar INSTANTLY "Quick-Breaks" the circuit on all poles.

TYPE "AT" CIRCUIT BREAKER UNITS AND APPLICATIONS

FRAME SIZES 50, 100, 225, 600 AMPS. 250V. DC; 600V. AC

Safe, Simple, Dependable "AT" Units Are Featured in All of the Following Trumbull Equipment

Enclosed Industrial Circuit Breakers — furnished also in special enclosures, including explosion-proof.
Circuit Breaker Panelboards
Circuit Breaker Switchboards
Circuit Breaker disconnects in Combination Magnetic Starters
Circuit Breakers in Control Center units

- Provide Automatic overcurrent and short circuit protection.
- In moulded phenolic case — dead front — sealed to prevent tampering.
- Common trip—all poles open on overload or short circuit on any pole.
- Solderless connectors — ratings clearly imprinted on handles—arc quenching chamber — toggle mechanism — quick make, quick break — tip free.

Illustrated and described in Trumbullaid Circulars Nos. 314, 315, 318, 321, 330 and 333 available on request.

FOR INDUSTRIAL USE

Type "AT" Enclosed Industrial Circuit Breakers. Also Available in cast iron Explosion-proof enclosures for hazardous locations.

IN PANELBOARDS

"AT" Circuit Breaker heavy duty distribution panelboards for light and power. Also "NAB" lighting Panelboards.

IN SWITCHBOARDS

Typical Circuit Breaker Switchboard containing "AT" breaker units.

THE TRUMBULL ELECTRIC MANUFACTURING CO.

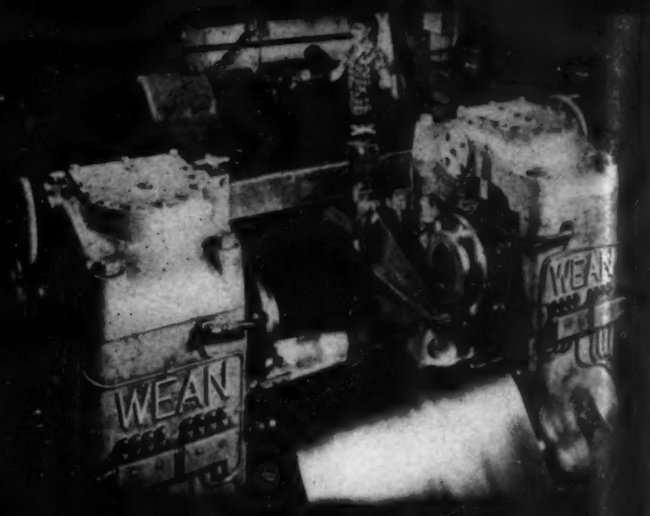
A GENERAL ELECTRIC ORGANIZATION

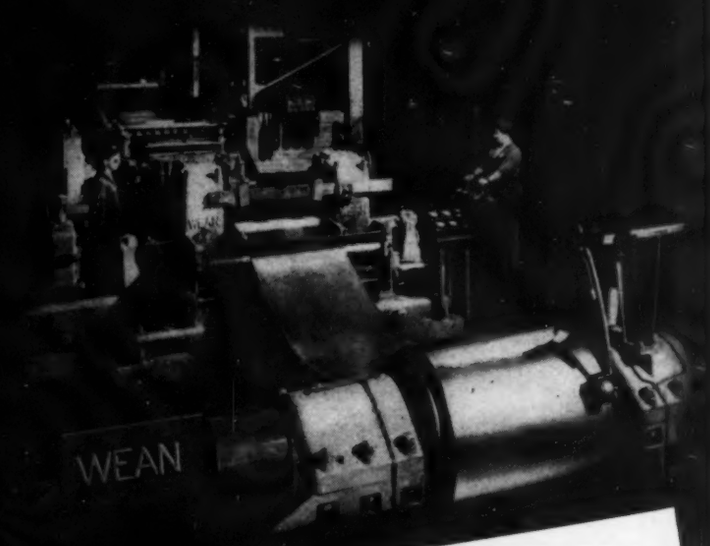
OTHER FACTORIES AT NORWOOD (CINN.) O.
SEATTLE — SAN FRANCISCO — LOS ANGELES

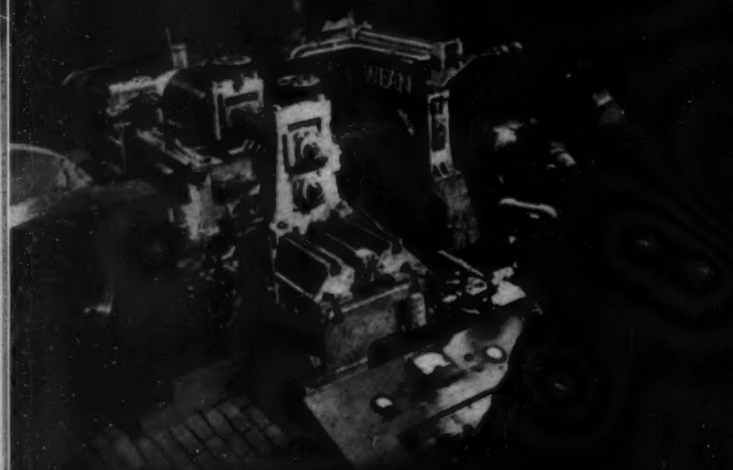
PLAINVILLE, CONNECTICUT

WEAN

SHEARING, SIDE TRIMMING AND SLITTING EQUIPMENT *for* STRIP STEEL







THE WEAN ENGINEERING CO., INC.
WARREN, OHIO

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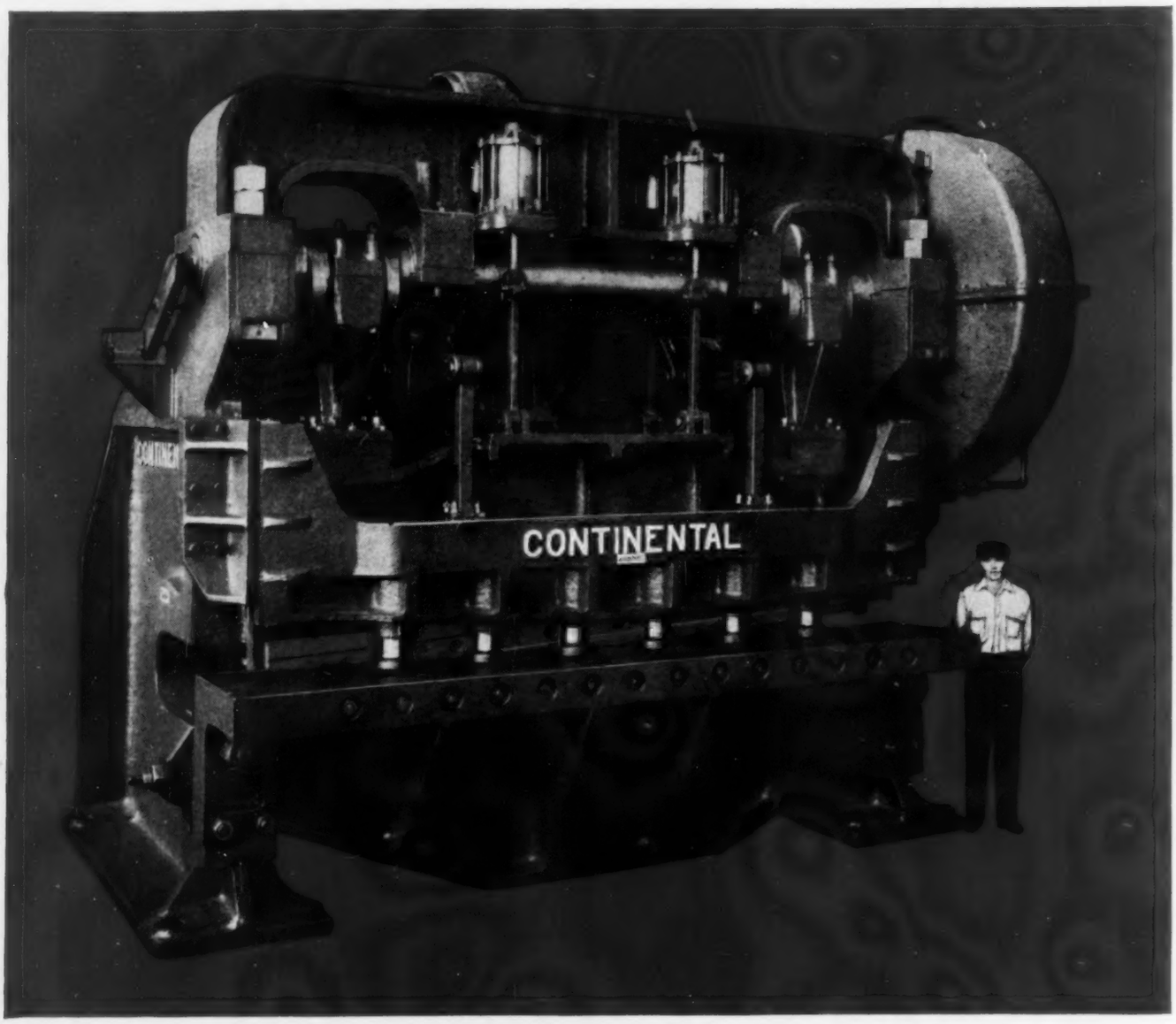

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Gas Turbines FOR BLAST FURNACE BLOWERS

. . . . gas turbines offer certain advantages without sacrificing reliability . . . . blast furnace operators might well consider these advantages in planning replacement or extension of blowing equipment . . . .

by **PAUL R. SIDLER**
BROWN BOVERI AND COMPANY, LTD.
NEW YORK, NEW YORK

▲ MANY technical journals and popular magazines have in recent months devoted considerable space to a discussion of the combustion gas turbine and its many promising applications. From this sudden wave of publicity it might be concluded that this prime mover is a discovery of the recent war years. Such is however not the case. Work on gas turbine schemes has been carried on by many engineers in various countries since the beginning of this century, more or less consistently and with more or less success. From the very beginning it was recognized that the success or failure of a gas turbine set is closely related to the characteristics of its air compressor, particularly to its power consumption or efficiency. Early attempts had no practical results because the compressor absorbed all the energy which the gas turbine could produce.

Work on gas turbine problems was thus for a long time largely concerned with the development of an efficient air compressor or blower. It is of interest to note here that the world's first practical centrifugal compressor, shown in Figure 1, was built in 1906 for use with a gas turbine project pursued in France. While this particular application of the centrifugal machine was not a success, there were many interesting uses in other fields, notably as blast furnace blowers, driven by steam turbine. Fourteen turboblower sets manufactured by the writer's company were installed in European steel mills between 1906 and 1910, five sets also in the Western Hemisphere, in Canada and in Chile. A few years later the first American-built centrifugal blast furnace blowers began to appear on the market.

American practice was and still is largely based on water cooled blowers. Believing that the advantages gained from water cooling can also be realized by improved design of the blower wheel and diffusor without the complication and cost of a cooling water system, we have consistently worked on air cooled blast furnace blowers and actually introduced this design in the United States in 1926 with a set installed in the Edgar Thomson Works of the Carnegie-Illinois Steel Corporation in Braddock, Pennsylvania. Several other units have since been installed in large American blast furnace plants.

Work on centrifugal blowers, for which many new applications were found, led to the development of superchargers for four-cycle diesel engines, consisting of a single-stage blower wheel driven by a single-stage exhaust gas turbine on the same shaft. These units are now being used in large numbers by almost every builder of four-cycle diesel engines in the world. They must be regarded as forerunners of the present power gas turbine, and have indeed contributed substantially

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to the body of experience necessary for successful gas turbine work.

Another step forward was made by the introduction in 1930 of a steam generator using combustion under pressure and forced water circulation. The pressure of 25 to 35 psi gauge in the combustion space is produced by an air compressor which in turn is driven by the exhaust gas from the boiler through a multistage gas turbine. This arrangement results in a very compact design using only 10-12 per cent of the space needed by a regular water tube boiler for the same capacity, and higher efficiency. The very first commercial unit of this type was installed in a steel mill near Caen in Normandy in 1932. It was built for burning blast furnace gas, and in its early life experienced some difficulty resulting from wide variation in the dust content of the gas. After improved cleaning methods were installed, it accumulated 70,000 hours of operation until the end of 1943.

These early steam generator units included a centrifugal blower for the combustion air, but it was soon recognized that a blower of still higher efficiency was needed to make these plants entirely independent from outside power sources, except for a brief starting period.

In 1934 the first multistage axial flow compressors were used in charging sets of boiler units and immediately changed the former power deficit into a surplus, sufficient to drive the feed pump, circulating pump and fuel pump.

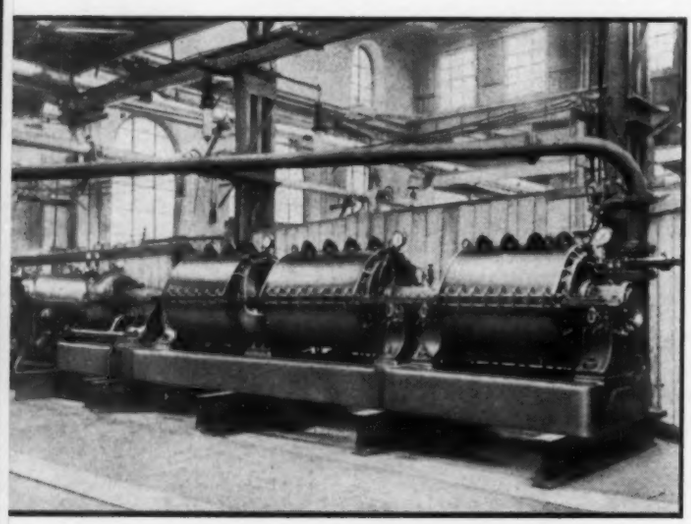
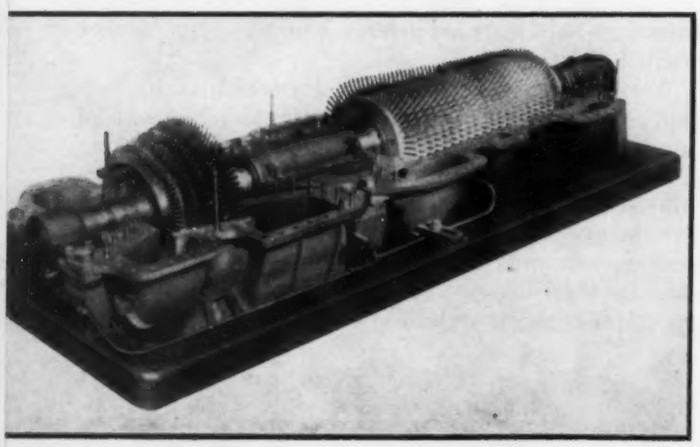


Figure 1 — First centrifugal compressor in the world, built in Switzerland in 1906.

Figure 2 — Gas turbine driven axial compressor (top removed) for use in oil cracking process.



The main advantage of the axial compressor was its higher efficiency, compared to the centrifugal machine, obtained without having to resort to water cooling in the pressure range up to 40, and more recently, to 60 psi gauge.

Up to 1942 the author's company built about 90 axial compressors in various sizes for these boiler units, over 20 large machines up to 125,000 cfm for wind tunnels and refrigerating plants, and another 20 units for the catalytic oil cracking process and power gas turbines.

In the cracking process, large air volumes are required to reactivate the catalyst by burning off coke deposits from oil vapors in regular intervals. The resulting mixture of hot combustion gas and air is expanded through a multistage gas turbine which drives the air compressor and shows a substantial power surplus.

Most of the gas turbine driven axial compressor sets for the refinery application were built in two standard sizes, for 23,000 and 40,000 cfm respectively. Figure 2 shows the first of these units, without the top cover. To the left is the 5-stage reaction gas turbine which develops 5300 kw with a gas inlet temperature of 900 F. It is coupled to a 20-stage axial compressor delivering 40,000 cfm at 45 psi and consuming 4400 kw.The difference of 900 kw is taken out as electrical energy through the generator coupled to the right end of the shaft through a reduction gear 5200/1800 rpm.

This set was installed in the Marcus Hook, Pennsylvania refinery of the Sun Oil Company in the fall of 1936 and has been in practically continuous operation since January, 1937 except for short periods of inspection every 6-8 months. It was soon followed by other units and after the first units had demonstrated their reliability, their construction was begun under license in the United States. During the recent war years, nearly 30 sets have been completed for plants in this country, producing high octane gasoline. Their design follows closely the one shown in Figure 2 except for a few minor changes.

For independent power units, which are not restricted by the requirements of a chemical process, the axial compressor is built with three or four additional stages to deliver a pressure of 60 psi and the gas turbine operates with an inlet temperature of 1120 F. It would normally be built with six or seven reaction stages.

The basic gas turbine power cycle is shown in Figure 3. With an atmospheric inlet temperature of 60 F, the air is discharged at 60 psi and at temperatures of 360-380 F. It then enters the combustion chamber where about 25 per cent participates in the combustion of the fuel, while the greater part passes around the burner where it helps to cool it and then is mixed with the hot combustion gas to reduce the temperature to the desired limit of 1120 F. The pressure drop through the combustion chamber is 1 to 1½ psi, so that the gas enters the turbine at 58½-59 psi and expands to atmosphere, with an exit temperature of 600-615 F.

A 4000 kw set following this simplest layout was completed in 1939 as a standby unit for a municipal power plant in Switzerland. With a maximum gas temperature of only 1000 F, it showed a thermal efficiency of 18 per cent. Based on the experience gained with several other units and by going to the safe limit of 1120 F, the efficiency of a gas turbine plant of the same size and layout built today could be guaranteed as

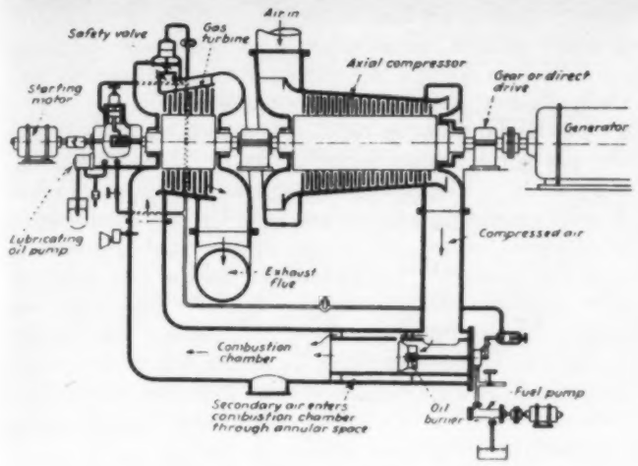


Figure 3 — Diagram showing the basic gas turbine cycle.

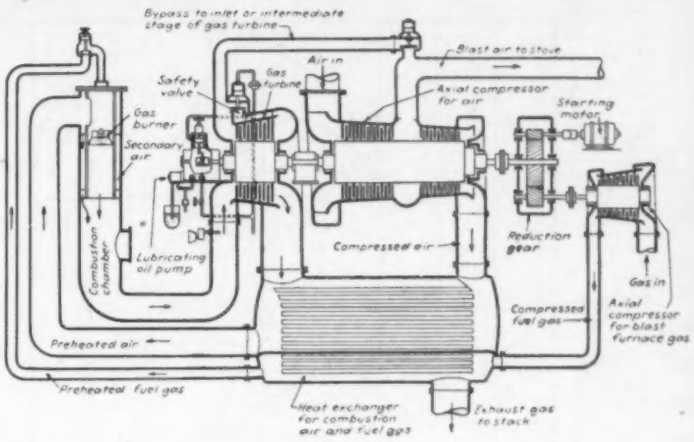


Figure 4 — Drawing showing arrangement of gas turbine driven blast furnace blower.

21 per cent. By adding a heat exchanger of about 10,000 sq ft (2.5 sq ft per kw) utilizing the heat in the turbine exhaust to preheat the air before the combustion chamber, the efficiency could be raised to 23.5 per cent.

Further improvements can be obtained — at the expense of simplicity and cost — by subdividing the air compression into two stages with intercooler between and by raising the inlet temperature to the gas turbine. The step from 1120 to 1200 F will be possible as soon as present restrictions on certain alloys are relaxed.

Since 1939 we have built and delivered three additional gas turbine generator sets in sizes between 1500 and 3000 kw for power plants or experimental purposes, a 2200 hp set for a locomotive of the Swiss Federal Railways operating since the summer of 1941, and two gas turbine driven blast furnace blower sets of 59,000 and 35,000 cfm respectively. A third blast furnace set of similar capacity could not as yet be delivered due to war developments. A large gas turbine power unit for 10,000 kw is under construction and should be ready for tests soon.

Extensive shop tests were carried out with these units before shipment and provided valuable checks for the computations. Censorship restrictions have so far prevented any detailed disclosure of operating data for the blast furnace blowers, but enough information has reached the factory to confirm the anticipated results, and to provide a basis for offering such sets with firm performance guarantees.

In adapting the basic gas turbine diagram of Figure 3 to the blast furnace application, it is merely necessary to omit the generator and its gear and to devise an extraction pipe around the middle of the axial compressor from which the blast air is tapped. It is also desirable to connect an axial blower for the furnace gas fuel to the same set through a suitable gear. The arrangement will then be as shown in Figure 4. The total air volume handled in the axial compressor is made up of the blast air, tapped at about 30-35 psi, the combustion air and the cooling air, both compressed to 60 psi gauge. This total is 2.2 to 3 times as large as the blast volume alone. Even a variation of the blast volume from maximum value to zero will therefore reduce the total air volume only from 100 to about 53 per cent in the extreme case. The conditions imposed upon the governing devices will thus be substantially less exacting than in the case of the centrifugal machines with steam turbine drive where small fractional volumes may be required.

The products of combustion pass directly through the gas turbine. In order to avoid any corrosion in the blading it is necessary that the blast furnace gas be dry and cleaned to a maximum dust content of 0.013 grain per cubic foot. While the experience with the boiler units burning blast furnace gas under pressure has shown this limit to be adequate for continued service over many years, a still higher degree of cleanliness provides even greater safety. Most plants use also blast furnace gas for heating coke ovens and therefore have equipment for keeping the cleanliness below 0.01 grain per cu ft. In such a case it will naturally be desirable to use the same gas for the combustion chamber.

The disgram also shows a heat exchanger in the gas path after the turbine, using some of the heat content to raise the temperature of the combustion air and of the fuel gas. The thermal efficiency of the plant increases in direct proportion to the surface of this heat exchanger. A limit is however imposed by the practical considerations of cost and space requirement in comparison to the gain in heat economy.

Figure 5 shows the pressure-volume curves of centrifugal and axial compressors for constant speed and their adiabatic efficiency. The p-v curve of the axial machine is much steeper than that of the centrifugal compressor, i.e. the pressure drops more rapidly when the volume increases. Since standard American operating practice requires regulation for constant volume while the pressure may be varied to meet changing blast furnace conditions, the very steepness of the curve enables the axial compressor to hold the volume close to the desired value over a wider pressure range. To put it differently, the governing devices will not have to operate so frequently or for so long a period to keep constant volume as in the case of a centrifugal machine. As the elements of the governing system are the same for both compressor types, this results in quicker response of the axial machine.

With both machine types the steam or gas turbine drive allows easy speed variation over a wide range.

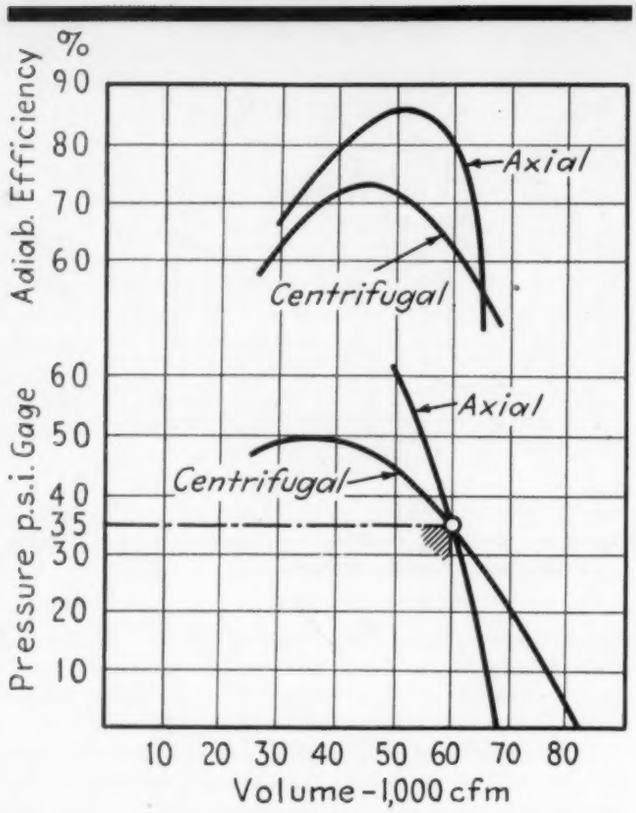


Figure 5 — Curves showing characteristics of centrifugal and axial compressors.

The fact that the axial compressor does not require speed reduction down to zero volume — since no blast delivery means a reduction of the total volume down to about 53 per cent only — has already been noted. This feature again puts the axial compressor in a more favorable position as regards governing range. In addition, the combination of gas turbine and axial compressor is easily adapted to blow-off or by-pass regulation with good efficiency, whereby any surplus air volume is led back into the gas turbine at a suitable pressure stage and helps to develop driving power. Also in this respect the gas turbine driven axial blast furnace blower is much more flexible than the steam turbine driven centrifugal compressor.

Both types of compressor have a multitude of pressure-volume curves, one for each speed, as shown in the diagrams Figure 6. To the left are some curves of the centrifugal compressor, at the right the corresponding characteristics of the axial machine. In both diagrams the normal operating point, corresponding to 100 per cent blast volume and 100 per cent blast pressure — also 100 per cent speed — has been designated as NP. It is of course important that this point is not too close to the pumping limit, in order to allow for the usual wide variations in operating conditions.

In the diagram at left the natural pumping limit will be reached with a centrifugal compressor having fixed diffusors or with fully opened movable diffusor blades. An extension of the operating range to the left is obtained with movable diffusors, adjusted to the required operating data. The pumping limit shown to the left can be obtained if about half of the diffusor blades are movable and controlled during operation. If it is desirable to increase the range still further towards small volumes all the diffusors can be designed with movable blades, resulting in approximately the same extension as for the step from fixed diffusors to half their number designed with movable blades.

For the diagrams at right, it has been recognized that the pressure-volume curve of the axial compressor is practically a straight line near the normal point. The normal operating area is bounded by the temperature limit curve for the gas turbine at the right and bottom and the "natural" pumping limit to the left and top. This limit can be extended to the left, with high economy, by by-passing excess air volume to the gas turbine at the proper pressure stage. In extreme cases larger air volumes can be blown-off to the atmosphere without the efficiency losses customary when blowing-off from centrifugal machines.

For normal operating conditions it is sufficient to obtain an increase in the blast volume by about 25 per cent with or without a corresponding pressure rise. In case of a hanging charge, the blast pressure is usually increased by about 50 per cent, preferably without substantial reduction in the volume. Here again the steeper characteristic of the axial compressor will enable it to reach the desired operating point in shorter time and with less demand on the governing devices.

In the diagram at the right several operating points have been marked with the numerals 1-7, the latter being the normal point. These conditions will be discussed further below in connection with a specific case.

When comparing the characteristics of centrifugal and axial blast furnace blowers, it has already been noted that the governing system employs the same elements in both cases. This will be more evident from a perusal of the diagram Figure 7. In accordance with our standard practice for all turbomachinery, the governing devices and all lubrication points are fed from a common pressure oil system through a main oil pump (7) gear-driven from the main shaft. A motor-driven auxiliary pump (8) provides oil pressure during starting and shut-down periods.

The main governing element is the speed regulator (9) in which a centrifugal governor controls the passage of pressure oil in accordance with the speed of the blower set. This variable oil pressure acts upon the by-pass valve (10) for the fuel gas and thereby changes the fuel supply to the combustion chamber. Governor (22) is provided to obtain constant blast volume or, if desirable, constant blast pressure. In this case the speed governor is set for the maximum speed of the unit reached in normal operation. It will thus only act when the set reaches its maximum permissible speed to prevent tripping and shutting down by the overspeed governor.

The volume governor is of the same design as usually furnished for centrifugal machines, with a membrane deflected by the pressure differential across an orifice plate. It is connected to the delivery side of the blower, i.e., the outlet for blast air. This is necessary because at the suction side the air volume is made up of the blast, the combustion, and the cooling air.

The arrangement with volume governor connected to the delivery side was adopted with complete success on most of the centrifugal blast furnace blowers which our company furnished for installation in the United States and other countries. In some cases difficulties

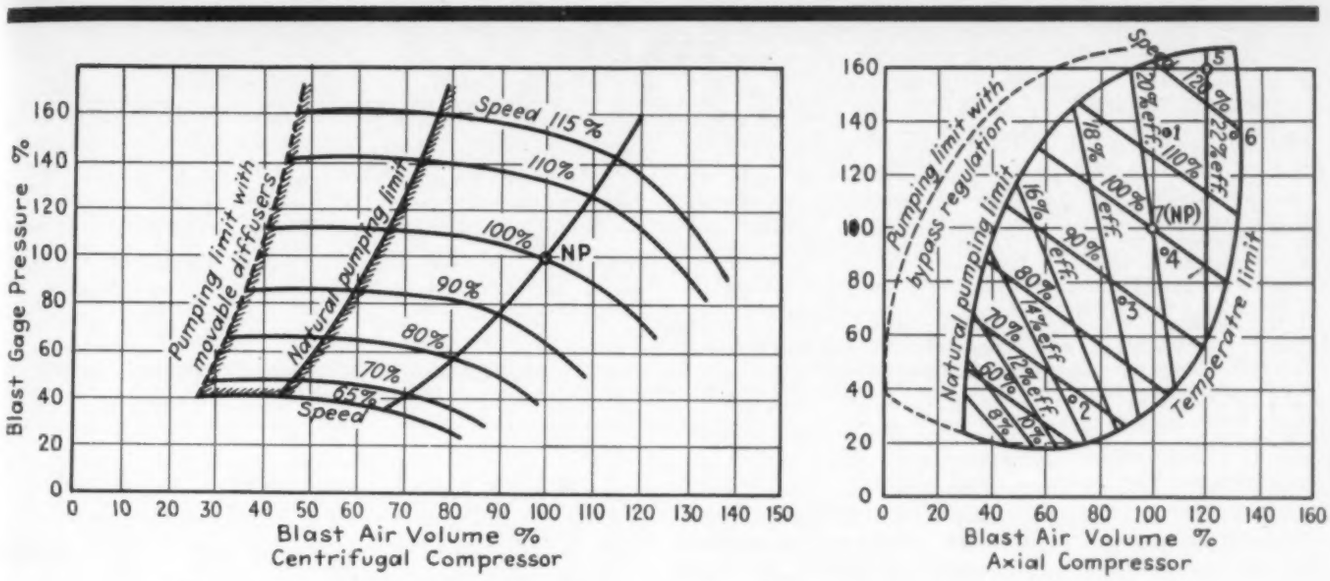


Figure 6 — Operating curves (pressure vs volume) of centrifugal and axial compressors.

seemed to arise through the necessity of finding a sufficiently long straight pipe section in the delivery main in which to install the orifice. By a special design of orifice grid which produces the same effect as a straight pipe section, this difficulty could always be eliminated.

In order to obtain stable operation also with volumes smaller than the "natural" pumping limit, the by-pass connection between the blower delivery and the gas turbine has been provided. Check-valve (17) in this line is so adjusted that it opens just before the pumping limit is reached and allows the surplus air not wanted in the blast line to flow to a suitable stage in the gas turbine where it helps to furnish driving power.

By this method it is however not possible to reduce the blast volume down to zero, while the blower is running at normal speed. For this purpose an additional oil-operated blow-off valve (not shown in the diagram) is provided, which comes into action when the check valve is fully opened.

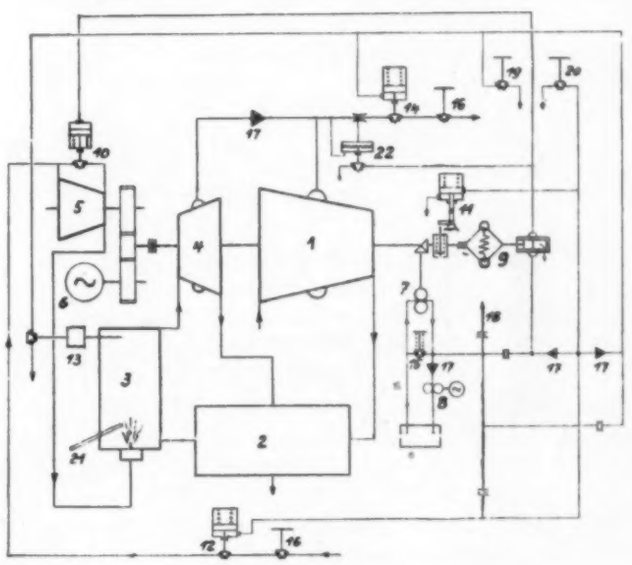
Among the customary safety devices, the overspeed governor (11) will be noted. It is adjusted for 10 per cent overspeed and eliminates the governing oil pressure, thereby causing the fuel by-pass valve (10) to open fully and the fuel stop valve (12) to close. In this manner, the fuel supply to the combustion chamber is stopped immediately and the set slows down due to lack of hot driving gas. Thermostat (13) operates when the combustion gas temperature becomes too high and, if sustained, would endanger the turbine. It acts upon valve (14) in the blast line and reduces the blast volume. This results in a larger combustion air volume and a consequent temperature drop in the gas/air mixture reaching the turbine.

If desired an electrically remote controlled release can be added to stop the set in case of emergency. Hand operated valves (19 and 20) for regulating the blast volume and the fuel gas supply make it possible to change the operating conditions independently from the automatic setting. This is particularly useful when starting the blower set, when tapping the furnace, or in difficult cases of a hanging charge.

Figure 8 shows diagrams of three different designs for blast furnace blower plants. Comparative data will be found in Table I.

A. Steam plant with standard water tube boiler (1) steam turbine (2), centrifugal blower (3) and brick stove (4).

Figure 7 — Sketch showing arrangement of governor for gas turbine driven blast furnace blower.



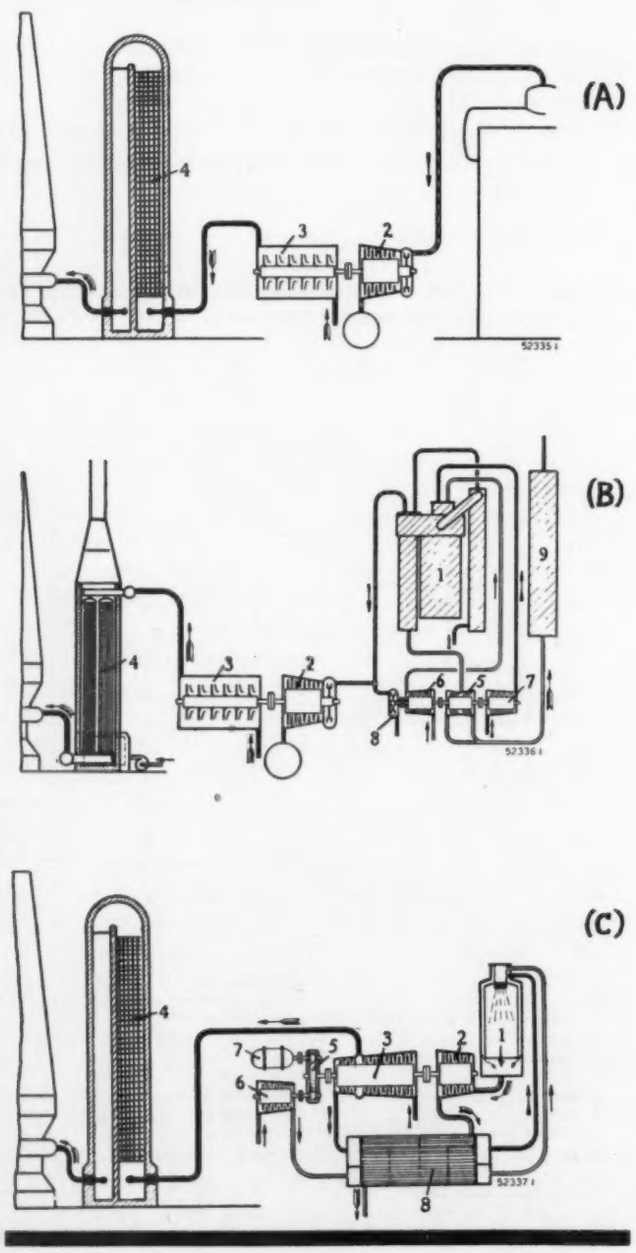
1 Air blower
2 Air preheater
3 Combustion chamber
4 Gas turbine
5 Gas blower
6 Starting motor
7 Main oil pump
8 Auxiliary oil pump
9 Speed governor
10 By-pass valve for fuel gas
11 Overspeed trip
12 Fuel gas stop valve
13 Thermostat
14 Air-flow limiting valve
15 Oil safety valve
16 Stop valves
17 Check valves
18 Lubricating oil to bearings
19 Hand valve for regulating blast air
20 Hand valve for regulating fuel gas flow
21 Ignition rod
22 Pressure regulator

TABLE I

Item	Figure 8			Figure 9
	Plant A	Plant B	Plant C	Plant D
1. Blast volume, cfm	47,000	47,000	47,000	53,300
2. Blast pressure, lb	17	17	17	17
3. Turbine output, kw	2,970	2,970	2,720*	2,700*
4. Efficiency of compressor, per cent	75.5	75.5	82.5	82.5
5. Hot blast temperature, F	1,380	1,380	1,380	1,472
6. Heat consumption per cu ft of blast air (with hot blast stoves), Btu	48	46.6	46.6	.....
7. Heat consumption per cu ft of blast air (with steel blast heater), Btu	45.7	44.3	44.3	37
8. Total enclosed building space for power plant, cu ft	233,000	100,000	60,000	112,000**
9. Cost of complete power plant without buildings and foundations, per cent	100	80	75	115**

*Power output for blast compression only.
**Includes steel blast heater.

Figure 8 — Diagrams of different arrangements of blast furnace blowers. A — Conventional layout. B — Layout with supercharged boiler and steel blast heater. C — Gas turbine plant.



B. Steam plant with a supercharged steam generator (1), steam turbine driven centrifugal blower (2, 3), and steel blast heater (4). The supercharged boiler has an air compressor (6) for its combustion air, driven by gas turbine (5) which also drives fuel gas compressor (7). On the same shaft is a starting steam turbine (8) also used for initiating load changes. (9) is the economizer.

C. Gas turbine plant with combustion chamber (1), gas turbine (2), axial air blower (3), brick stove (4), gear (5), axial blower for fuel gas (6), starting motor (7), and heat exchanger for air and fuel gas (8).

In plant B a steel blast heater is shown, as this happens to have been provided in the actual plant under comparison. The accompanying table gives some of the main data of all three plants, adjusted for the same blast conditions, which were not the same in the plants built. For A and B the steam conditions at the turbine inlet are 483 psi, 750 F total temperature. In all three cases, the heat content of the blast furnace gas is 102 Btu per cu ft.

For plant A the space and cost of the coal handling equipment is included under items 8 and 9. Plants B and C do not include this equipment, as neither the supercharged boiler nor the gas turbine is at present developed for burning coal even in finely pulverized form. Research work on coal firing has been carried on for several years and may result in a practical solution in due time.

Under item 8 no attempt has been made to translate space requirements into building costs. With the large difference in space the advantage of the gas turbine plant C is noticeable.

Neither plant includes provisions for supplying and treating water for steam and condensation although this is an important cost factor in many steel plants. It must be remembered, however, that the gas turbines plant C requires no water.

Steel tube blast heaters as per diagram B with combustion under atmospheric pressure have been used in Europe experimentally but are so far limited to a maximum hot blast temperature of 1380 F. Blast heating then becomes a continuous process with resulting advantages in simpler operation and smaller space requirements. The steel tubes exposed to high temperatures must of course be built of special alloy steel and

there is as yet insufficient operating experience for arriving at definite conclusions on the life of these elements.

Designing a steel blast heater with combustion under pressure (as established in the supercharged boiler), high gas velocities and consequently smaller heat exchange surfaces result in a substantially reduced space, high thermal efficiency and low cost. With the heating surface reduced to only a fraction of that found in hearers having atmospheric combustion, it becomes economical to allow for replacement on the heating tubes in relatively short intervals.

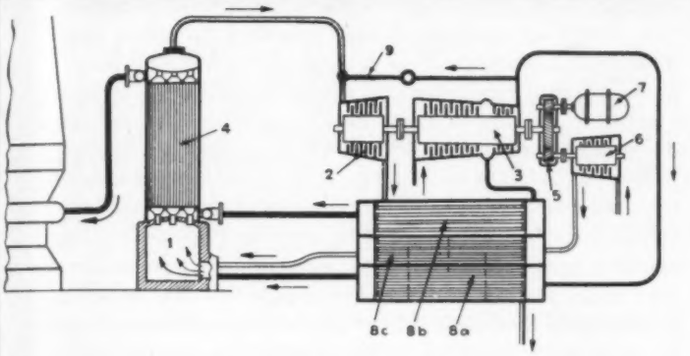


Figure 9 — Gas turbine driven blast furnace blower with supercharged blast heater.

A layout following these principles is shown in Figure 9, with individual parts designated as follows:

1. Combustion chamber.
2. Gas turbine.
3. Axial compressor.
4. Hot blast heater (higher temperature range).
5. Reduction gear.
6. Axial compressor for fuel gas.
7. Starting motor.

8a. Heat exchanger for combustion air.
8b. Heat exchanger for fuel gas.
8c. Heat exchanger for blast (lower temperature range).

9. Bypass line to regulate gas inlet temperature to turbine.

The gas turbine driven compressor set is similar to that shown in Figure 4. Blast heating occurs in two steps and two separate heat exchangers, with the gas turbine inserted into the gas path between the two exchangers. The heater for the higher temperature range, producing the final blast temperature, is built together with the combustion chamber and receives the uncooled combustion gases. After giving up a substantial part of their heat, these gases then enter the gas turbine, usually with a temperature not exceeding the permissible limit. In cases where the inlet temperature would be harmful to the turbine, a suitable air volume obtained through by-pass line (9) is mixed with the gas before the turbine inlet.

The second blast heater for the lower temperature range is located at the turbine exit and would preferably be combined with the heat exchangers for the combustion air and the fuel gas.

In Figure 9 the combustion chamber is only shown diagrammatically. In a plant actually built it may well take the same form as that shown in Figures 3 and 4.

One of the gas turbine driven blast furnace blowers mentioned in the preceding paragraphs (when discussing previous experience) was designed for the future addition of a supercharged steel blast heater following the arrangement just discussed. Installation of this heater must however await the end of the war and the availability of suitable alloy steels. Meanwhile the unit operates in conjunction with existing brick stoves.

Data on a definite project worked out for a blast volume of 53,500 cfm and a maximum blast temperature of 1,472 F have been added in Table I under column D. It should be particularly noted that in this case the supercharged steel blast heater is included in the total space (although it would probably still be located outdoors) and in the comparative cost of the complete plant. In columns A, B, and C the stove or blast heater is not included under items 8 and 9. This unbalance could not be avoided, as for an arrangement as in Figure 9 the blast heater forms an integral part of the power unit and cannot be segregated. It is of interest to consider that a complete plant including steel blast heater will cost only about 15 per cent more than the power plant with water tube boiler and steam turbine driven centrifugal blast blower, but not including the several brick stoves and their piping.

The layout of a gas turbine driven blast furnace blower set according to plant C in Figure 8 and worked out for the practical conditions in a large American steel plant is illustrated in Figure 10. The nominal blast rating is 60,000 cfm at 19-30 psi, but with the provisions to go to 75,000 cfm and 35 psi. The operating points numbered 1-7 in the right hand diagram of Figure 6 refer to this particular case.

In order to have all these points placed as favorably as possible, the 100 per cent position has been chosen for point 7 which corresponds to 58,250 cfm, 21.9 psi, 3300 rpm and shows a thermal efficiency of 20 per cent. It will be noted that the largest volume permissible under the temperature limit would be at 134 per cent or 78,000 cfm with corresponding pressure of 125 per cent or 27.4 pounds per sq in and a speed of 117 per cent or 3860 revolutions per minute. The thermal efficiency at this point is about 23 per cent.

The main dimensions of the set are shown in the layout. Despite the ample space around the machine set, for operation and dismantling, the total enclosed space is only slightly larger than that given in Table I for the 47,000 cfm set.

In this specific case for 60,000 cfm blast volume, the axial blower handles a total suction volume of 132,000 cfm. If units with larger blast volume are taken into consideration the total volume to be handled by the blower naturally also increases in about the same proportion. One might then encounter certain complications in design and will probably find it preferable to produce the total air volume in two separate blower housings. Seeing that the blast volume alone is somewhat less than half of the total, the simplest solution is then to provide one blower for the blast and another for the combustion and cooling air, both coupled together.

For 75,000 cfm rated blast volume, this arrangement has certain advantages and more so when still larger volumes are considered. Providing two separate blowers naturally increases the axial length of the set, but does not affect the building length in the same degree.

In Figure 10, the total length of the machine set is shown as 55 ft, 5 in. For a 75,000 cfm set with two blowers, the overall length would be about 76 ft, for 90,000 cfm about 79 ft. The size of the air preheater will only increase slightly if the same thermal efficiency is maintained.

The gas turbine sets operating as prime movers in Switzerland and other countries of Europe have not been in continuous day-and-night operation for various reasons — for instance the shortage of oil due to war conditions — and have therefore not accumulated as many operating hours as would otherwise have been expected. However, the record of the Neuchatel 4000 kw set which has been operated intermittently for 4½ years, that of the Swiss gas turbine locomotive which meanwhile covered over 50,000 miles, representing about 3000 hours for its power plant, and the somewhat scanty data collected from other gas turbine sets permit definite conclusions as to the life expectancy of individual parts and the amount of maintenance required at regular intervals.

It should be recalled here that the three main elements of the present gas turbine power unit, the gas turbine proper, the axial compressor, and the pressure combustion chamber, have been in regular service in the steam generator since 1930 and in the refinery gas turbine driven compressor sets since the end of 1936. The temperature conditions in these applications, especially as regards the gas turbine blading, are closely similar to those encountered in the gas turbine driven blast furnace blower. The pressure is somewhat lower — 35-45 psi gauge instead of 60 psi — but again not too different for valid conclusions.

Several boiler units installed during 1931-1934 have meanwhile completed 70,000 hours of operation, many others following with 50,000-30,000 hours, and the gas turbines still retain their original blading. All the other parts of these charging sets needed no major replacements either, but merely annual inspections, occasional replacements of labyrinth strips, and oil changes.

The first gas turbine set for the oil cracking process has been in practically continuous operation since January 1937, except for regular shut downs for inspection every six months. It has operated for more than 8000 hours every year, or a total of over 60,000 hours, again without requiring any major replacements or any attention beyond routine check-ups. In view of the uncertainty as to the life of the gas turbine blading when this set was ordered in 1936, it was decided also to order a complete spare gas turbine. After observing the operation of the set for two years, the owners quite properly reached the conclusion that this spare unit would not be needed for replacement in the visible future, and therefore installed it for regular operation together with a newly purchased axial compressor. The record proves that this decision was fully justified. The same satisfactory experience was obtained with the six other gas turbine sets installed in

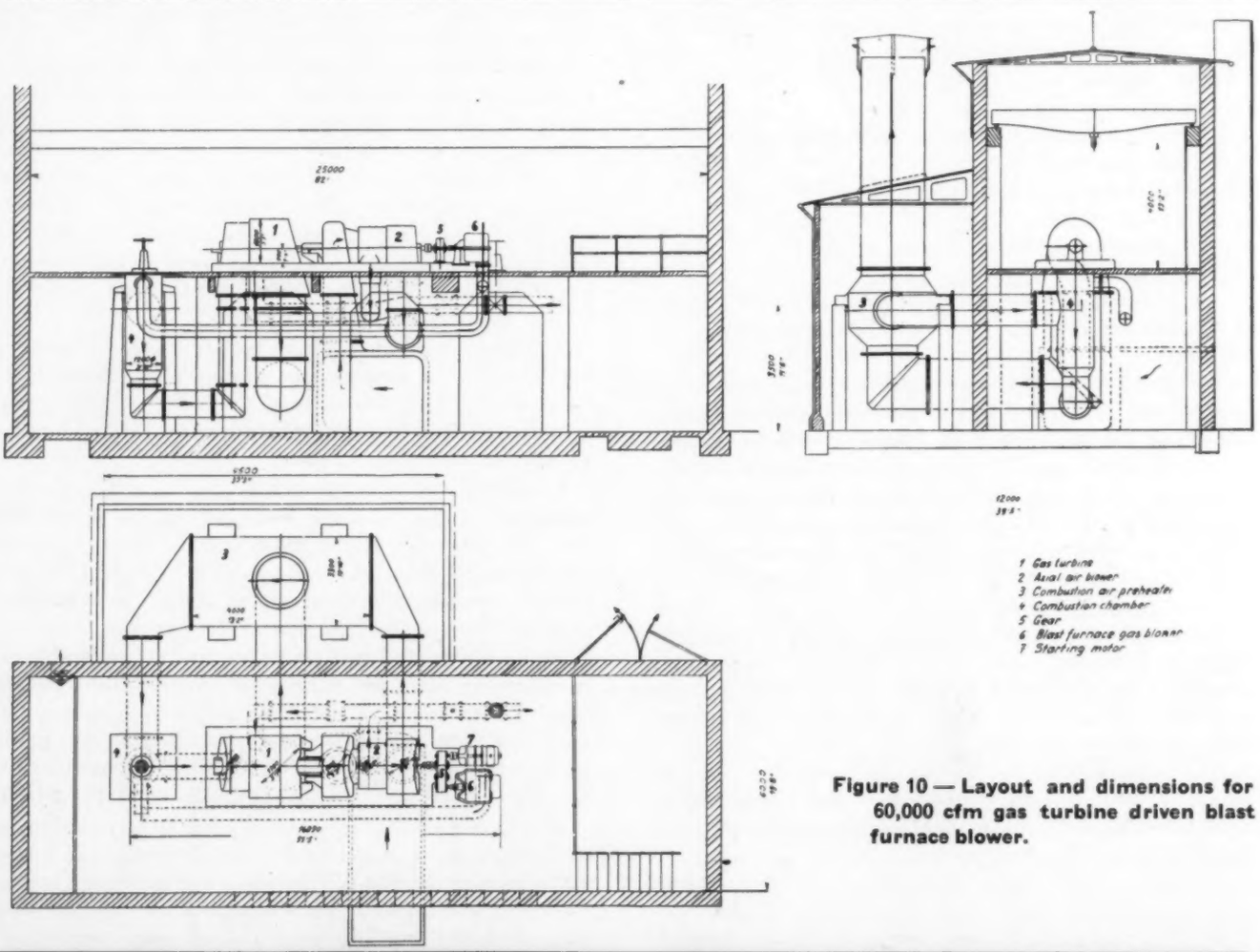


Figure 10 — Layout and dimensions for 60,000 cfm gas turbine driven blast furnace blower.

cracking plants in this country during 1938 and 1939.

Based on this record, it can be definitely asserted that gas turbine driven blast furnace blowers require no more replacements or maintenance than is customary for any steam turbine driven centrifugal unit. The advantages of the gas turbine plant can therefore be obtained without sacrificing any of the reliability that has for years been the accepted standard in steam turbine plants.

It is believed therefore that the operators of blast furnace plants will wish to give serious consideration to these advantages for replacements as well as extensions of existing furnace installations.

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DISCUSSION

PRESENTED BY

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F. K. FISCHER, Central Station Steam Engineer, Westinghouse Electric and Manufacturing Company, Philadelphia, Pennsylvania

W. P. HILL, Assistant Superintendent, Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland

P. R. SIDLER, Resident Engineer, Brown, Boveri and Company, Ltd., New York, New York

A. J. FISHER, Fuel Engineer, Bethlehem Steel Company, Sparrows Point, Maryland

O. J. MENKE, Special Process Engineer, Island Creek Coal Sales Company, Cincinnati, Ohio

J. S. Fulton: Mr. Sidler is to be commended for outlining a new cycle of blast preparation that presents the possibility of decreasing blowing costs, because we are confronted with the probability of these costs increasing in the near future from decreased qualities in the raw materials fed to the furnace. I will confine my comments to the practical side of the cycle he proposes because I do not have sufficient knowledge to pass judgment upon the thermal efficiencies he outlines.

It seems to me that Mr. Sidler has not paid sufficient attention to the radical difference between European and American blowing practice, i.e., to the American practice of maintaining the delivery of a constant volume of blast to a single furnace, regardless of the normal and abnormal fluctuations in blast pressure set up by the furnace reactions. Mr. Sidler states that the maintenance of constant volume will be no more difficult with a gas turbine driven blower than with a steam driven blower. However, an inspection of his governing cycle discloses the fact that it is equivalent to attempting to maintain constant volume with a steam driven blower by controlling the fuel burned in its individual boiler or controlling the escape of compressed air through the snort valve.

In the alternate scheme where the tubular heat exchanger provides the 1384 F temperature in the air flowing to the gas turbine and as hot blast temperature in the air flowing to the furnace, Mr. Sidler misses the practical fact that the hot blast temperature is varied to suit the furnace, irrespective to the ordered volume of wind or the prevailing blast pressure. Consequently, the furnace demand for hot blast temperature might be 200 F on either side of the temperature required by the gas turbine. As I said at the beginning, Mr. Sidler is moving in the right direction but it is possible that the practical necessities might wipe out the margin in fuel economy he has outlined.

F. K. Fischer: I think Mr. Sidler has handled the subject very realistically and has presented a very good story of the application of the gas turbine as a blast furnace blower drive. I am pleased with the realistic manner in which he has handled the story because there has been a tendency to hold up the gas turbine as a revolutionary engine design, a perfectly new engine development which will replace all other types of engines, which we know it will not. It has a field, a very definite field, and we hope to see if held within these limits and not held out to do things which it cannot possibly fulfill.

The article certainly is timely as there is tremendous interest in the gas turbine, this interest undoubtedly is due to the wartime applications being found for the gas turbine. The pioneering work done by Mr. Sidler's company in the gas turbine field has certainly been a great stimulus to engineers in this country who were completely satisfied that the gas turbine would reach the practical development stage without going to temperatures of 1500 F. There were some people with the general feeling that operating temperatures of at least 1500 F would be necessary before the turbine could be practically developed. From the prewar industrial applications at temperatures of the order of 1000 F, which Mr. Sidler describes, we know they are obtaining much practical operating data.

In this connection, the war has produced a peculiar situation in gas turbine development. Engineers in this country have been interested in the gas turbine for many years and there was considerable active development in this country before the war. With the approach of war, the government, so to speak, has taken over the gas turbine in connection with its wartime applications. Under this government sponsorship we can expect that we are getting many years of experience in a very short period of time. Normally, a new development would take a relatively large number of years to develop and work out the various problems. Under this government sponsorship, the development is going ahead at a tremendous rate. Although at present, wartime restrictions naturally apply, once the war is over we will have the benefit of the tremendous amount of actual experience being obtained from the gas turbine in the wartime applications. Developments in materials for high temperatures are also going ahead at a rapid rate, and we can undoubtedly look forward to materials capable of substantially higher

continuous operating temperatures than were possible before the war.

Referring specifically to the gas turbine as applied to the blast furnace blower, Mr. Sidler's table is of particular interest. It shows the normal steam turbine drive with its blast furnace blower at unit cost and shows the cost of a gas turbine driven blast furnace blower unit as 0.75. This indicates — and I believe that most engineers who have followed the gas turbine will agree — that the cost may be lower for the gas turbine drive, particularly, where we are dealing with the simple gas turbine and avoid such things as the large building space, the boiler, condenser and necessary water connections for the steam drive application.

In speaking of efficiency, Mr. Sidler bases his efficiency on 60 F inlet air. The gas turbine efficiency changes with the temperature of the inlet air — the higher the inlet air temperature, the lower the efficiency. If he were to use 100 F inlet air, which I feel is a more logical inlet temperature for the blast furnace blower, his efficiencies would be lowered by something of the order of 10 to 15 per cent.

He obtained a very good efficiency in the arrangement where he combined the combustor with a steel blast heater. His indicated cost, however, is 15 per cent higher than the standard steam turbine driven blower arrangement. In this respect, it is unfortunate that he was not able to get a general idea of the cost of the stoves for heating the blast air. With this cost added to the standard steam turbine blower and to the simple gas turbine driven blower, his costs for his various arrangements would be truly comparative.

The material for the steel blast heater would have to be stainless steel or some material good for very high temperatures. However, I do not believe this should be an insurmountable problem, because we know boilers are being operated in this country in connection with oil refineries at 50 psi pressure and temperatures of 1400 F.

I am sure that the operators of steel mills who are interested in problems in connection with blast furnace blowing can look to the gas turbine as being a good possibility as a blast furnace blower drive. It will probably show slightly higher efficiencies than the steam plant, and may possibly have slightly lower maintenance costs. The maintenance of steam turbines in general has been a little better than that of the boiler. When we consider the maintenance of gas turbine blower units, we must consider the saving in building requirements and the elimination of boiler and condensers.

The steel mill operator can certainly look to the gas turbine as being a probable competitor to other methods of blast furnace blower drives in the future. He can rest assured that the manufacturers in this country are going to have considerable experience when the war is over and will offer gas turbine applications if they prove justifiable.

W. P. Hill: I didn't see any impulse in your turbine. I was wondering what reaction you installed in that turbine.

Does the turbine go through a critical in coming up to speed, and what is the C value, that is, the wheel speed to the steam speed in these blowers?

What is the longest length of blade you are using at present, and what wheel diameter?

How does the lubrication hold up under considerable length of time if you are operating at cherry red temperature?

P. R. Sidler: In regard to the questions brought up by Mr. Fulton I said that if it is desired to regulate for constant volume, this is very easily possible because of the steep characteristic of the axial blower. There is, however, no reason why one cannot get equally prompt response with this pressure governing system even if one were to regulate for constant pressure or variable pressure or variable volumes and pressures. This oil pressure governing system is known and has established its ability to respond very promptly. The machines themselves, the gas turbine and the axial compressor, are much lighter in their rotating parts than are steam turbines or centrifugal compressors, and therefore have less inertia than these other machines. In other words, this governing system applied to gas turbine driven blower sets will show, and in many actually built plants has shown, that it does respond to any requirement that may be placed upon it.

In regard to varying blast temperature, Mr. Fulton has mentioned the long distance that occurs occasionally between blowing engines and furnaces. Naturally, if such conditions exist, that cannot be avoided, but the temperature regulation again is an easy matter in this arrangement. Also, the fact that these units require very substantially less space would make it possible to place the blowing engine closer to the furnace.

I generally agree with Mr. Fischer's comments on the possibilities of gas turbines, and I have always maintained that there is no point in holding out future hopes as to what they will do if, as, and when we are able to build gas turbines for gas inlet temperatures of 1500 F. What I have been trying to say is that the gas turbine is practical now without waiting for any future development of high temperature alloys.

As regards the use of such metals in boilers for temperatures of 1400 F, or in that general range, it should be noted that in boilers the problem is easier because we have water on one side of the surfaces.

In regard to the questions asked by Mr. Hill, I am sorry to say that I do not have definite design figures. In a general way, however, the gas turbine is built so that there is no critical speed in its entire range — that is, from starting up to the maximum speed that it will ever reach. That accounts for the heavy shafts that are noticeable in some of these pictures.

The length of blades depends entirely on the size of the machine, but blade lengths of four or five inches have already been used in some of these axial compressors that have been built.

In regard to the gas turbine, it is reaction blading throughout, although in steam turbines we have for many years been advocates of combinations of impulse and reaction blading. The degree of reaction is about the same as in steam turbines.

In regard to lubrication, it is clear that we must prevent excessive heat on the bearings. That is done by suitable insulation in the gas turbine casing and substantial labyrinths on the shaft which are fed by cooling air at a suitable pressure; so we believe that we have been able up to now to avoid any difficulty with lubrication, even in the bearing next to the turbine inlet, that is at the highest temperature spot. Some of these machines, as I have said, have run some seven or eight

years and the charging sets in the supercharged boilers have run some twelve to fifteen years, and so far there has not been any trouble with the lubrication.

J. S. Fulton: I do not think that Mr. Sidler caught the practical objection to linking into one governing system the maintenance of constant blast volume and of variable hot blast temperature. In other words, the furnace foreman might decide that the hearth required either 1180 or 1580 F hot blast temperature at the time the blower load required 1380 F at the entrance to the gas turbine. Consequently, if the furnace foreman, as is usual, can control the hot blast temperature at either of these levels, he would upset the delivery of constant volume, or, if he is not permitted to control the hot blast temperature, the furnace would be upset.

P. R. Sidler: In the diagram showing the blast heater as an integral part of the gas turbine system (Figure 9) there is a by-pass line between the blower discharge and the gas turbine inlet. It should be particularly noted that this line connects to the end of the blower, i.e. the discharge for combustion and cooling air, and not to the discharge tapping for the blast air. This makes the amount of air needed for mixing with the gas — if the gas should have too high a temperature — quite independent of the blast volume which can still be maintained constant.

In other words, we change the amount of fuel to regulate the final blast temperature as desired and we use some of the combustion and cooling air — not the blast air — to bring down the temperature at the gas turbine inlet if it should be too high.

In a plant actually built there would also be a by-pass line from the blast discharge tapping to a suitable pressure stage in the gas turbine in order to take advantage of bleeding for wide blast volume regulation. This second by-pass line has not been shown in the diagram Figure 9 for the sake of simplicity.

A. J. Fisher: I would like to ask Mr. Sidler if he would discuss the cleanliness of blast furnace gas required for gas turbines, and whether or not it would be desirable to use the gas in a hot condition from the top of the furnace if it could be cleaned.

P. R. Sidler: It is my understanding that it is quite general practice nowadays to clean the gas for other uses, anyway, to somewhere in the neighborhood of .01 grains per cubic foot. I mentioned the figure of .013 as having been established in supercharged boiler work as satisfactory. That is only slightly higher, I know. It will have to be in that general range, and with that degree of cleanliness, we have the assurance that the turbine blading will stand up.

Whatever temperature the gas does have after cleaning is naturally desirable for the thermal economy of this plant. It is my understanding that quite a bit of the temperature is lost during the cleaning operation.

W. P. Hill: This large volume of blast furnace gas has to be compressed, and if you are trying to compress it at 400 F, your blower efficiency is going down pretty low, isn't it?

P. R. Sidler: That is true.

W. P. Hill: Then your thermal efficiency is lost many times over by keeping it hot.

P. R. Sidler: It all depends on what temperature you are talking about. Of course, when you say 400 F we would have to cool it before compressing it.

O. J. Menke: Could we use pulverized coal in the turbine, on one-furnace operation, rather than have an extra steam plant? This would be for emergency only.

P. R. Sidler: No, sir, not at this time. I stated that I was not going to talk on the burning of pulverized coal, and somewhere along the line I also mentioned that, while we have a research project going, it is not ready yet for commercial application and it may take a few more years; indeed, it is not even possible to estimate what time it will take until a solution is found.

A. J. Fisher: One more question. Nowadays coke ovens are being built for blast furnace and coke oven gas combination underfiring. Would there be any advantage in underfiring the coke ovens with blast furnace gas and then taking the coke oven gas, which is at 500 Btu, to the gas turbine? How would that affect your thermal efficiencies throughout, just briefly?

P. R. Sidler: As soon as we use a richer gas, quite generally speaking, we get better efficiency. We do not need to handle as large volumes, and thus it would be very desirable, if one does not have more lucrative uses for the coke oven gas. The question is largely economic. Does one want to use it in this plant or can one not use it to better advantage elsewhere or sell it? It was assumed that in normal situations, one would probably have much better uses for coke oven gas, but as far as the gas turbine is concerned, it will do very well with it. Also it is certainly of interest to consider coke oven gas as stand-by fuel as long as we cannot as yet use powdered coal.

Increasing the Power ON EXISTING Cold Strip Mills

. . . . so rapid has been the development of cold strip mills that many of the earlier mills are economically obsolete . . . . higher speeds, which will benefit many of these mills, may be possible of attainment through various means . . . .

by F. R. BURT and B. J. AUBURN
WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY
EAST PITTSBURGH, PENNSYLVANIA

▲ THE output of a cold strip mill can be increased by increasing the load factor, decreasing the percentage of scrap and off-gauge product, or increasing the delivery speed. The load factor can be increased by accelerating and retarding at higher rates, by threading at higher speeds (particularly in the early passes), by rolling longer coils and by eliminating lost motion on the part of the mill crew. Faster acceleration and retardation and higher threading speeds will also result in a lower percentage of off-gauge strip. However, on a successfully operating mill, only a comparatively small increase in output can be obtained by the above methods, and any large increase requires higher delivery speeds and consequent higher horsepower.

The delivery speed of cold mills has increased eightfold in the past 12 years, and it will be increased further. No one at the present time can predict what the ultimate maximum speed of these mills will be. Almost every increase in speed has resulted in problems that had to be solved in order to extend apparent limits of one kind or another. As the speed is increased, the difficulties of rolling increase and troubles are magnified. Mishaps which would not be serious on a low speed mill may cause extensive damage and delay. Eventually speeds will be reached beyond which it is not economical to go.

An increase in speed of an existing mill involves both the mill itself with its gearing and coolant and lubricating systems, and the electrical apparatus. It is necessary of course that the mechanical design be checked before proceeding on a program involving higher loads or speeds. Each request for an increase in power on a mill must be treated as a problem in itself, since in no two cases will the solutions be the same.

The simplest case, since it would involve no change in gear ratio, would be that of a tandem mill driven by motors having speed ranges of 2:1 by field control which must be operated in the lower part of the speed range on certain high tonnage schedules to prevent overloading of part or all of the motors. The rated speed range is satisfactory, but full advantage cannot be taken of the field weakening. Here the problem is usually one of obtaining a moderate increase in output from existing motors or from new motors having increased horsepower capacity at the same speed and if possible occupying the same space.

If it is desired to increase the rated mill speed the change in equipment will be more extensive, since in addition to increasing the motor capacity, it will be necessary to change the motor speed, or the gear ratio, or both.

On most tandem mills, space for the motors is at a premium. Figure 1 is typical of an arrangement which has been used in several plants. Two mills are located parallel to each other with the motors end to end. Although the motors could be increased in width, there is very little space available for increasing their length. There are mills arranged as shown in Figure 2, with the

Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pa., Sept. 25-27, 1944

motors sandwiched between each other, and as in Figure 3, where the motors are located between the gears and the mills. On these layouts there is practically no room for increasing the motor dimensions in any direction. Even where space is available, it means a considerable saving if the old bedplates can be used.

Since the mill is already in existence, it is easy to determine from test the power requirements under the desired conditions. Knowing the power required, the various possibilities of obtaining it should be examined, starting with the simplest and cheapest and progressing until the power available matches that required. These possibilities might be tabulated as follows:

1. Increasing the ventilating air.
2. Cooling the ventilating air to a lower temperature.
4. Allowing higher motor temperatures by the use of class B insulation.
4. Installing larger parts on the same bedplate.
5. Installing a complete new motor having an increased rating.

The temperature which a motor will reach is dependent on the rate at which heat is generated in it due to its losses and the rate at which this heat can be removed. Neglecting the small amount moving along the shaft and into the foundation by conduction, all the heat must be transferred to the air surrounding it and passing through it. As the losses increase the temperature rises and the temperature differential, and therefore the heat transfer, increases until at some temperature the heat is transferred out of the machine at the same rate at which it is generated. At this point the temperature becomes constant. In a large machine such as is used in a main drive most of the heat is removed by the air passing through the internal air passages and a comparatively small amount by radiation from the exterior.

For practical purposes, air will absorb an amount of heat proportional to its volume and to its temperature rise; supplying more ventilating air, suppling it at lower temperature, or allowing it to rise to a higher temperature will enable a motor to carry higher loads. Just how far this can be pursued will depend on the particular motor design. Most motors driving cold mills are of relatively high speeds and the fixed losses will be approximately half the variable losses at full load. On such a motor the relation between increase in load above 100 per cent and the increase in losses above full load losses is shown in Figure 4.

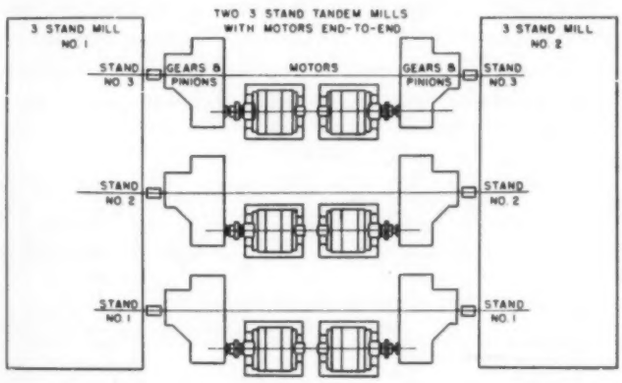
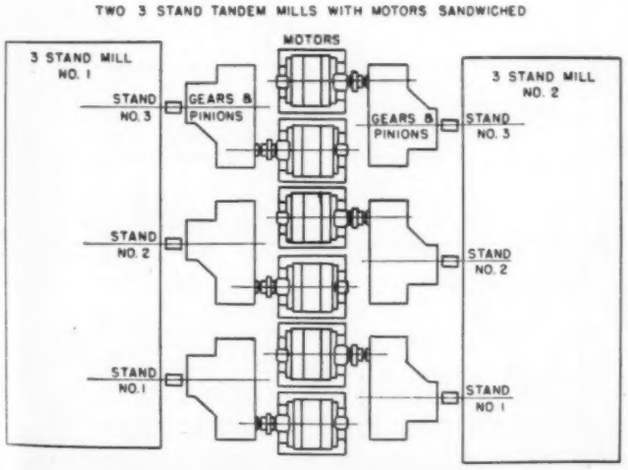


Figure 1 — Typical arrangement of cold mills in several plants.

Figure 2 — Another arrangement of cold mills with motors of two mills sandwiched together.



INCREASING THE VENTILATING AIR

Until other limits are encountered, the loading could be increased by supplying more ventilating air at the same temperature in proportion to the increase in losses. However, it is found that the relation between heat transferred to the ventilating air and air velocity through the machine is not a straight line but definitely breaks above a certain velocity, taking on the trend of a saturation curve as shown in Figure 5. Since the shape is different for different designs, no definite values are shown. For a normal motor the relation over the straight part of the curve is approximately 125 cfm of air equals one kw transferred.

On a slow-speed motor the variable losses are many times the constant losses, so that the losses increase almost as the square of the load. The capacity of such a motor cannot be increased very much by increasing the ventilation.

Practically all cold mill motors are force ventilated, either by a nonrecirculating system which filters and blows air at outside temperature through them, or by a recirculating system which takes the warm air discharged from the motors, cools it by means of air-to-water heat exchangers and returns it to the motor air intakes. In either case it may be possible to increase the ventilating air a sufficient amount by increasing the capacity of the fans and the filter or heat exchangers without disturbing the duct work. A figure of 2000 fpm has been used arbitrarily as the limit of air velocity through ducts, but there is no reason why this cannot be exceeded if enough pressure is provided to overcome the additional resistance. On most installations, the velocities will be found to be considerably below this value. If the air ducts must be increased in area, it may mean a major change, particularly if concrete construction is involved.

COOLING VENTILATING AIR TO LOWER TEMPERATURE

If it is found that sufficient benefit cannot be obtained from an increased supply of air, or if it is impractical on

account of changes required in the ventilating system, the motor capacity can be increased by supplying the same amount of air at a lower temperature. A motor with class A insulation is ususally rated to carry full load with a 40 degree rise above 40 C ambient temperature, which gives a total observable temperature of 80 C. If the ventilating air could be delivered to the motor at 68 F, which is 20 C, the motor could rise 60 degrees without exceeding 80 C total temperature. Theoretically, this would allow 50 per cent more losses to be dissipated or the motor could carry approximately 30 per cent more load.

The problem is of course to get the 68 degree air under conditions of high outside temperature. If this were to be accomplished by means of air-to-water heat exchangers, it would require a large volume of water at approximately 60 F which is rare and costly in steelmaking districts. However, air temperatures of this order can be easily obtained by mechanical refrigeration using cooling water available in any mill. Such a system would be economical only when used with recirculated air, since, if fresh air were circulated through it, a large percentage of the capacity would be used in condensing moisture during periods of high humidity. It would be connected in series with the existing cooling system so that it would need remove only the additional losses. Assuming a 1500 hp motor, 50 per cent of full load losses can be absorbed by 12 to 15 tons of refrigeration. This can be furnished as a self-contained unit approximately 7 ft long, 3 ft wide and 6 ft high, requiring only connection of water and electrical service and attachment to the duct system. Such a unit is shown in Figure 6. It would be automatically controlled to maintain the air leaving the motor at a constant temperature. It would thus absorb the peaks; during periods of light load or cold weather when cold water is available for the heat exchanger, the latter would carry most or all of the cooling load.

Figure 7 shows an arrangement that might be used for supplying cooler air to one or more motors on a tandem mill. It is assumed that the basement is under pressure, this pressure forcing the cool air up into the rear end bells of the motors which are open to the basement. The warm air is drawn downward from the front end bells, through the warm air duct, thence through the heat exchanger and fan and back into the basement. This is a rather typical layout where the motors are not enclosed in a motor room. The refrigerating unit, in which booster fans are incorporated, picks up air which has already passed through the heat exchanger, cools it still further and forces it into the rear end of the motor through a closed duct.

In case it is necessary to provide additional cooling for all the motors, it might be more economical to mount the cooling coil in the main air duct following the heat exchanger and to use a separately mounted compressor.

ALLOWING HIGHER MOTOR TEMPERATURES

Any gain in capacity which can be realized by increasing the volume or decreasing the temperature of

Figure 3 — Arrangement of cold mill with motors placed between gear sets and mills.

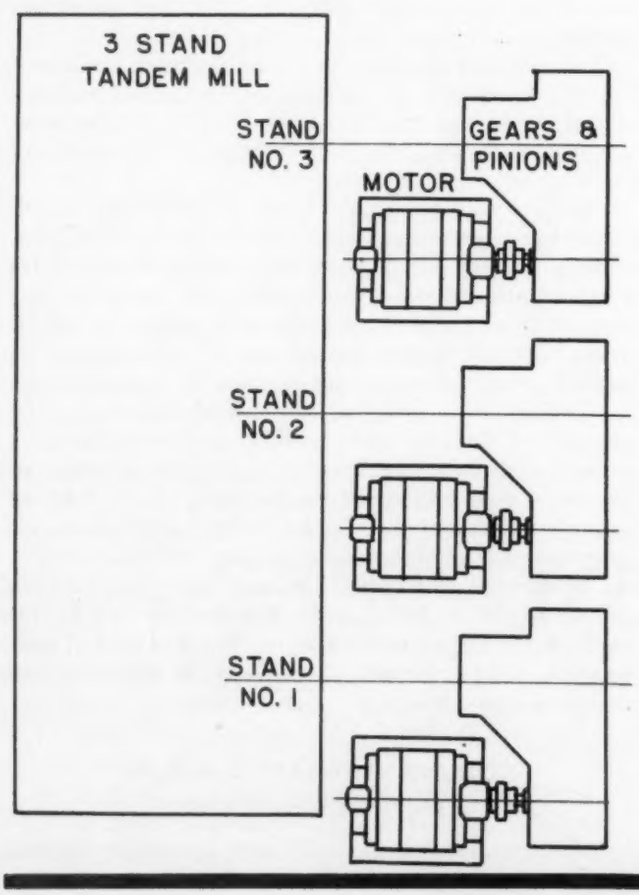
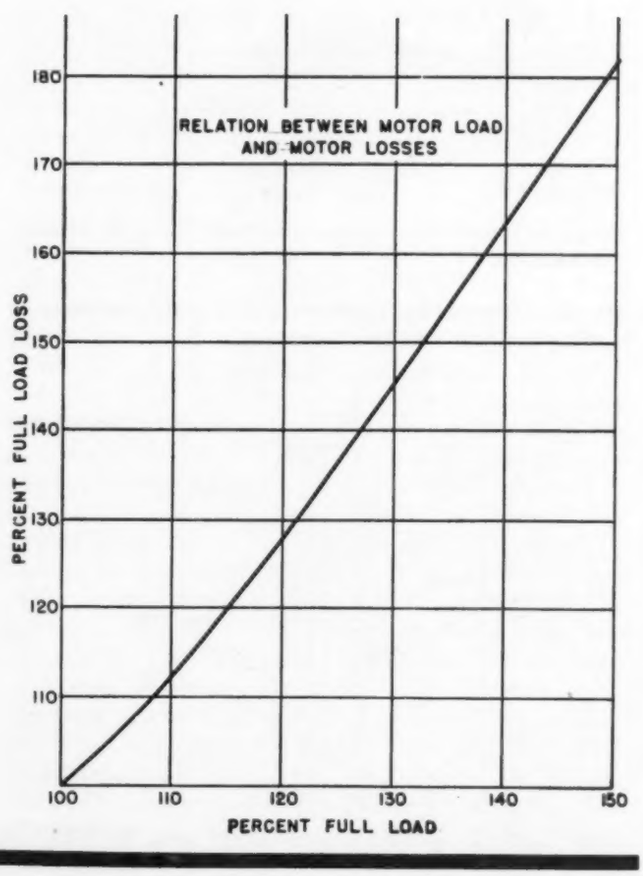


Figure 4 — Curve showing relation between motor load and motor losses.



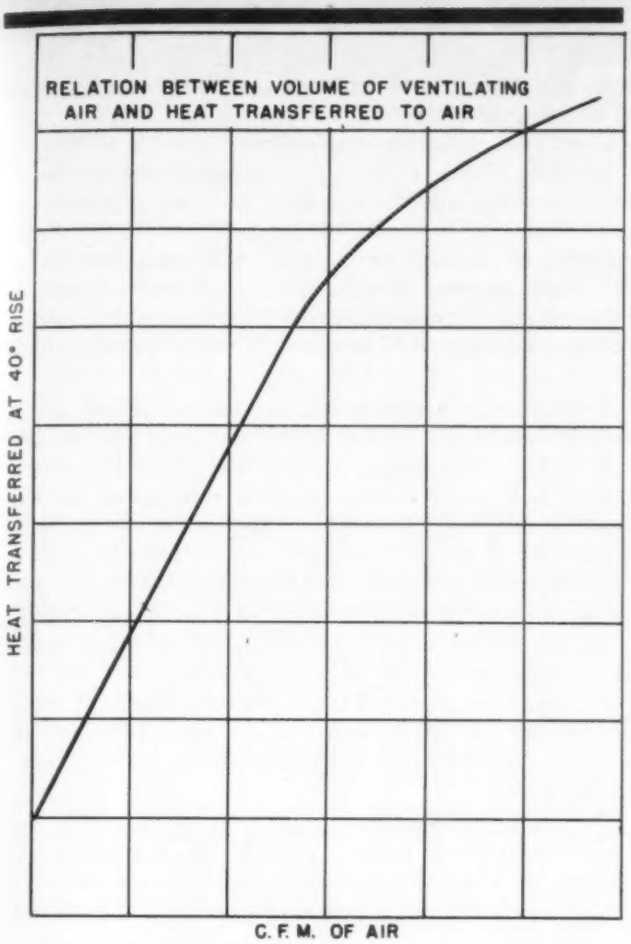


Figure 5 — Curve showing relation between volume of ventilating air and heat absorbed.

the ventilating air is obtained without change in the motor. On some installations, however, it will be difficult to obtain the space for additional ventilating or cooling apparatus. In these cases the possibilities of class B insulation should be investigated. A class B insulated machine can be rated at 60 C rise using the same hot spot allowance as on a class A insulated machine rated at 40 C rise. This will allow 50 per cent more temperature rise or again approximately 30 per cent increased load.

Any of the above changes will of course only enable the motor windings and, to a lesser extent, the commutator and brushes to carry an increased continuous or rms heating load. The motor will not be capable of commutating higher peaks, and if this becomes a limitation the interpole design should be examined. It is possible that new interpoles can be furnished which will increase the commutating capacity, particularly if the motor is not of recent design.

The higher loads will result in higher current density in the brushes, and increased brush wear and commutator maintenance can be expected. If this becomes a limitation, some advantage can be obtained from the use of thicker brushes, or double brushes, or it may be found that space is available for a longer commutator. In no case should the loading be increased to a point where poor commutation results or brush and commutator maintenance become excessive, since the effects of both are cumulative.

The peak loads on tandem mill motors occur during acceleration and are therefore a function of the accelerating rate. If it is found possible to increase the continuous capacity, but not the peak capacity, it may be economical to operate at the higher loads and slow the accelerating rate down. This is true particularly if long coils are being rolled, because in that case the accelerating and retarding time becomes a smaller percentage of the total.

At the higher loads, the speed drop under load will be greater and the operation under this condition will have to be checked.

LARGER PARTS ON EXISTING BEDPLATES

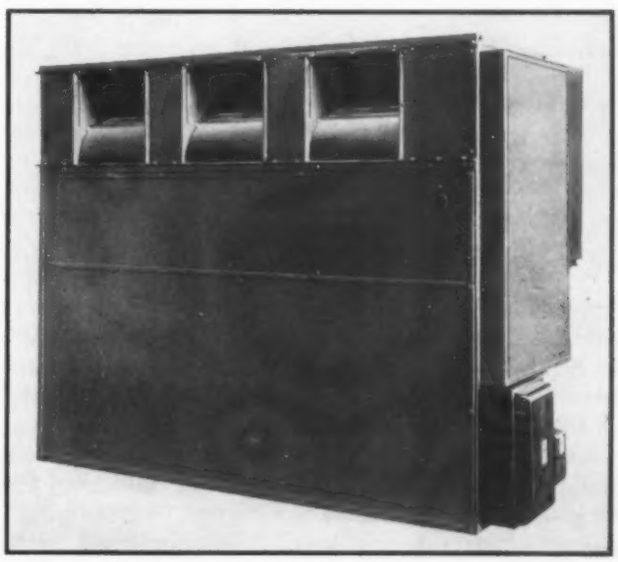
If the desired increase in capacity is greater than can be obtained by any of the above means, it will be necessary to replace the motor by one of larger dimensions. On a great many installations it will be found that a longer armature fitted with a larger diameter shaft can be accommodated on the existing bedplate by providing special short bearings. If the new parts are built with class B insulation, a considerably increased capacity may be obtained. In one instance the motor rating was increased 60 per cent without disturbing the bedplate. Additional ventilating air will be required approximately proportional to that part of the increase in rating obtained from the larger electrical parts.

COMPLETE NEW MOTORS

All possibilities of obtaining the desired rating and keeping the same mounting dimensions having been exhausted, the only remaining alternative is to substitute new motors on part or all of the stands. This is, of course, a major change and involves new foundations, ventilating equipment, control, and probably gearing.

The maximum speed for which a motor of a certain horsepower rating and speed range can be built is defi-

Figure 6 — This self-contained refrigerating unit may be used to cool the water used in fin-tube air coolers in a motor ventilating system.



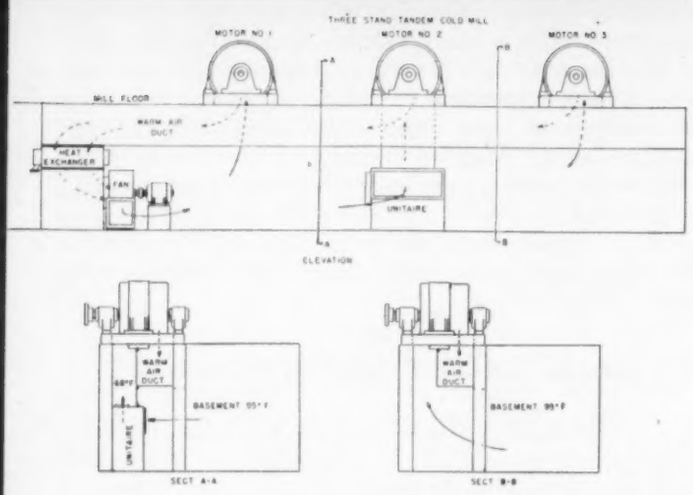


Figure 7 — Sketch showing arrangement to supply cooler air to one or more motors on a tandem mill.

nitely limited. The product of horsepower, maximum rpm, and speed range by field control should in general not exceed 25 x 10^6 for motors of 1500 hp and larger, and the allowable product decreases for lower ratings. On many mills the existing motors are close to this limit. Therefore, in increasing the horsepower rating, the maximum speed or the speed range, or both, may have to be reduced. Since the mill speed is at the same time increased, a considerable change in gear ratio may be required. It may prove desirable to discard the gearing entirely and apply a direct connected motor. If the limit in diameter is exceeded, either due to peripheral speed or available center distance between stands, the additional capacity must be obtained by lengthening the armature, but here again a limit is reached, since as the length is increased it becomes more difficult to reach all parts of the motor with cooling air, and also the reactance volts are increased and the commutation suffers.

If using a direct connected motor results in too high a product of horsepower, maximum speed, and speed range, it will be necessary to divide the total capacity between two armatures. For instance, assume a tin mill stand with 20 in. working rolls delivering at a maximum speed of 4000 fpm and requiring 3000 hp. A direct-connected motor would operate at 760 rpm top speed, corresponding to 4000 fpm. If built in a single armature, this motor could have no speed range by field control. If built as two armatures, it could be given a speed range of 380/760 rpm by field control. If the same stand required 3500 hp, a double-armature motor would be limited in speed range to 420/760 rpm or 1.8:1.

If a large increase is made in the delivery speed of a mill, the matter of inertia becomes important, particularly on the finishing end. A standard motor with a 2:1 speed range is guaranteed to carry occasional momentary overloads of 100 per cent throughout the speed range, frequent momentary overloads of 75 per cent at base speed, and 60 per cent at twice base speed. Therefore if full load is required for the reduction, the accelerating torque should not exceed 60 per cent of full load torque.

Using the same example as before, assume the last stand of a tandem tin mill, with 20 in. diameter working rolls and 53 in. diameter back-up rolls driven through a 1.88:1 gear reduction by a 1250 hp, 300/600 rpm motor. The maximum strip delivery speed is 1670 fpm. The WR^2 of the rolls is approximately 24,000 lb-ft^2 referred to the mill drive shaft. The WR^2 of a motor of normal design is about 16,000 lb-ft^2, or 56,000 lb-ft^2 referred to the mill drive shaft. Allowing 8000 lb-ft^2 for gears, pinions, spindles and couplings, the total is 88,000 lb-ft^2. To accelerate to 1670 fpm in eight seconds requires a torque of 11,400 lb-ft at the mill shaft, which is 55.5 per cent of full load torque.

It is desired to increase the maximum delivery speed to 4000 fpm, using a direct connected, 3000 hp, 380/760 rpm motor. This rating could be carried by two armatures, each of the same physical dimensions as the existing one, since the torque is approximately doubled. The WR^2 of the mill will still be 24,000, the double armature motor 32,000, and the pinions, spindles and couplings approximately 6000, or a total of 62,000.

To accelerate at the same rate as before would result in a torque of only 39 per cent of base speed, but the time would be extended to 19 seconds. The mill could not be brought up to speed in less than 12.2 seconds without exceeding an accelerating torque of 60 per cent of full load.

A motor could be built with smaller diameter and longer armatures having a WR^2 of approximately 24,000. With this motor the mill could be accelerated in 10.5 seconds without exceeding 60 per cent of full load.

POWER SUPPLY

Any increase in mill loading of course involves the power supply as well as the motors. On some mills the motor-generator set or sets are of such capacity that some additional load could be carried. In case it is necessary to increase the capacity, it may be possible to do so by increasing the volume of air, by supplying cooler air or by changing to class B insulation in the same manner as suggested for the mill motors.

If a motor-generator set must be added, it is an advantage to make the new generator or generators duplicate those already installed, since they must parallel and divide the load both at full voltage and while the voltage is being built up and down. The latter condition requires that the saturation curves have the same shape. On a new machine of different design, it may not be possible to exactly match the saturation curve of the existing generators, and if not, the load will not divide proportional to the ratings at reduced voltages.

If the rated strip delivery speed of the mill is increased, it will of course necessitate a change in the reel drive, involving a larger motor and probably a different gear ratio.

If the increase in motor rating is moderate, it may be that the existing control will have enough margin so it can be used with minor changes. If the increase in rating and speed is considerable, it will probably be necessary to replace the control, both on account of capacity and because higher speed operation requires features which probably were not originally included.

DISCUSSION

PRESENTED BY

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W. E. WINTERHALTER, Electrical Engineer, Carnegie-Illinois Steel Corporation, Dravosburg, Pennsylvania

F. R. BURT, Industry Engineering, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania

F. O. Schnure: This subject is one that can find application in practically any of the early cold mills. The first mill installed in our plant in 1936 was too slow after the first day's rolling and before the week was out was operating at 20 per cent over the motors' rated speed. But even this did not approach a satisfactory operation and three years later motors nearly 100 per cent larger were applied on the original foundations. Although designed for what was then thought the optimum speed, the paint was hardly dry on the job before higher delivery speeds were common.

The layout was that shown in Figure 3 of the paper, which is bad for reasons other than that of lacking possibilities for the application of still larger motors; the motors are located next to the mill and although enclosed are subject to the oily vapors from the mill. In this location it is difficult to inspect and service them.

Any change upward in load on the original equipment brings with it as the principal problem the elimination of the extra heat produced by the motors and generators. The authors have outlined several possibilities. Experience has been that insulation troubles increase with the operating temperatures. There is a classical rule for temperatures over 200 C that the life of insulation is doubled for every drop of ten degrees in temperature. That, of course, is probably more than double the temperature attained in usual steel mill drives, but nevertheless there is an inverse relation between the operating temperature and the insulation life.

Experience indicates there is no better investment than that of ample capacity. However, the problem the authors are attempting to solve on existing installations is how to restore that happy margin between ample capacity and overload after being crowded out by the demand for higher tonnages. They recommend increasing the ventilating air, which usually can be done. Their next step calls for cooling the ventilating air to a lower temperature and in this connection the suggested application of refrigerated air offers interesting possibilities. We all know that when air alone is used for ventilation its temperature follows the seasons and nothing can be done to improve hot weather conditions. The same factors usually influence cooling water when used in fin type coolers to condition the air. The mechanical air conditioner therefore presents a method of supplementing, in extreme warm weather, air conditioning by the more conventional methods.

There is, however, no substitute for ample capacity, and that means new motors. For nearly twenty years we operated a 3000 hp motor on a 4500 hp job and averaged a failure every year. When this old veteran began to limp so badly that it could not keep up with the ever increasing tonnage scheduled for its mill, it was replaced with a larger one which for six years has operated without any sign of distress. My belief is that, after all factors are considered, the cheapest and most satisfactory way in the end to secure increased capacity is by making whatever changes are necessary in order to apply new motors. The increase in generating capacity should follow the same principle.

F. Mohler: This paper is very timely as many are considering the speeding up of mills at this time. The growth of cold strip mills has been almost phenomenal. For instance, the delivery speed has increased nearly ten times in the past ten years. The highest speed mill now operates around 4000 fpm; the next around 2600; the next around 2400; and all of the other mills have a delivery speed of 2000 fpm or below. Some are still operating at from 500 to 900 fpm.

When contemplating the speeding up of mills, I strongly recommend a review of the fundamentals of the mills and their drives. It is well to reexamine the schedules which have been rolled and the schedules which are contemplated, and draw up a new speed cone to not only cover these schedules but also be sure that the most popular schedule lies approximately in the center of this cone. The next step is to calculate the horsepowers required for the various stands and the speeds of the motors to correspond with the most desirable speed cone.

The third step is to lay out the motors so that they will have a very low WR^2, as well as speeds and arrangements of the drives which will permit inherent synchronism in acceleration and deceleration. For instance, in order to obtain a good balance, it may mean that a motor should be direct connected, and either single or double armature. As a matter of fact, on some of the very high speed mills being contemplated it appears as though we will have to resort to twin drives on each stand, with each of the twin drives consisting of a double armature motor. This fundamental of having a well balanced mill is the most important in the high production of on-gage strip with a minimum of strip breakage and roll maintenance.

After the most desirable drives have been laid out in accordance with the foregoing, it is then time to examine your present drives as to whether they can be used or not. If they can be, all well and good, but do not compromise the operation of your mill just in order to use an existing motor.

To determine whether or not a motor has a low enough WR^2, I use the following rule of thumb. It should not require over 30 per cent normal full-load current to accelerate the motor alone from zero to full speed in ten seconds with weak field on the motor. However, the current to accelerate the motor does not give the whole picture. The WR^2 of the mill must also be taken into consideration, and not more than 60 per cent current should be used in accelerating the mill and motor from standstill to maximum speed in 10 seconds.

You will find that on most of the older mills little attention was paid to the WR^2 of the motors and they will be unsuitable from this standpoint alone in many instances. The very high speed modern mills have been made possible because, among other things, of the progress in designing larger motors of higher speeds with lower WR^2.

W. E. Winterhalter: Messrs. Burt and Auburn have done a splendid job of focusing attention on problems associated with increasing production and yield — problems which rarely, if ever, have the same answers for two mills. Nevertheless, from our experience the general observation is made that increase of mill speed and continuity of operation must be realized to a substantial degree in order to justify modification cost. Frequently, maximum realization of improved production, quality and yield is somewhat beyond basic justification and attainable at small additional investment cost plus risk associated with deeper projection into unexplored territory.

Space limitations are unfortunate impositions of original mill layout but do not usually prevent realization of objectives if mills are suitable for higher speed production of high grade product. Replacement of main drives and expansion of motor generator set capacity are usually more attractive than reinforcement, overloading and overspeeding of existing drives. Sometimes a number of existing drives can be reapplied to lower speed stands or used in making up tandem units.

Another observation from experience is that conversion of non-recirculating ventilating systems to enclosed recirculation with adequate make up, as well as cooling capacity to carry away losses, is more economical and effective than to resort to increased velocity of circulation. The use of refrigeration to supplement water coolers appears attractive, especially when cooling water temperature is high for a few weeks of the year. In this connection, it might be mentioned that substantial, removable ventilating system covers and doors, spacious, power operated air-lock doors, and quiet operation of the entire system are indicated for consistently satisfactory operation.

Use of higher primary circuit voltages, counter-emf exciters for field control, higher temperature, oil and moisture resistant cables with synthetic rubber conductor and jacket insulations, and built-up channel bus are effective in getting more power into available space. Use of 15½ gauge stranded multiconductor control cable with corresponding insulation has proven exceedingly helpful in getting more circuits through existing conduits.

Improved regulation of preset generator voltage, coiling tension, acceleration and deceleration forcing, IR drop compensation and excitation voltage is usually essential if the mill to be modified has been in operation more than 3 to 5 years.

Supplying power to regulators, controls and electronic equipment circuits from separate regulated d-c and a-c generators rather than from general substation supply circuits is a low cost investment in improved performance, reduction of delays, control failures and replacement costs. Insurance against accelerated deterioration, damage and failures of machine windings, controls, meters, and wiring by elimination of exposure to coolant, oil, dirt and mechanical damage is another low cost item when associated with modernization — one that will contribute substantially to the same results.

Evaluation of what permanently installed meters can do to improve product and performance of mills, reduce delays and provide a sound basis of uniform operating practice should not be overlooked in modernization planning. Thorough knowledge of operations, and of available meters and accessory equipment, is essential in realization of best results and control of investment in instrumentation systems.

From earlier comments, it appears that much agreement can be found in the assertion that, if modernization of an existing mill can be justified at all, it should be complete with desire to use available equipment subordinated to near future as well as immediate production and quality requirements. Experience with our two 5-stand tandem mills illustrates this point. Before No. 1 mill was placed in operation in 1938, but after main drive motors had been designed and were in process of manufacture, it was decided to increase the mill speed 20 per cent. Armature bands were reinforced to permit this increase. Another 20 per cent speed increase was added arbitrarily and tension reel regulating control replaced during the early months of operation. Sound basic design contributed to a performance record far above that originally contemplated, but as might be expected armature coils are thrown occasionally, and flexibility with which to meet increased production, higher yield and practice improvements has been limited.

When it was decided to install No. 2 mill, every practicable effort was made to profit by past experience. Numerous departures from usual procedure were made, including doubling the speed of No. 1 mill, elimination of all main drive gears excepting No. 1 stand, use of tandem drives for the last two stands and reel to improve coordination of acceleration and deceleration, and expansion of the opening of the entry end of the speed cone. This mill was designed to roll .07 in. to .095 in. thick strip to delivery gauges varying between .008 and .012 in. Since it went into operation in May, 1941, the delivery gauge band has been increased to nearly 5 (.005-.0242 in.) with occasional schedules rolled to .0035 in. The range of product and practice have been correspondingly expanded without encountering power or control limitations.

It is true that No. 2 mill was installed as a complete new unit; however, the installation was made in space allotted for a duplicate of No. 1 mill, and there does not appear to be any obstacle to addition of a similar or increased number of advanced features during mill modernization.

F. R. Burt: I believe there are no points of disagreement between anything mentioned in the discussion and our own opinions. I fully agree with Mr. Mohler that it is very desirable to keep the WR^2 down as low as possible and to keep down the accelerating peaks; if you do that, you have a much better operating mill.

Further, of course, it is much better, if possible to go the whole distance if you are going to make a change. When you tear these mills up and knock foundation walls out and make room to put in new motors that are twice as big, try to leave some wide open spaces around the new ones so that in five years you can double them again, because that is probably what is going to happen.

SYMPOSIUM—

Cleaning Steel

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Cleaning Steel FOR SUBSEQUENT COATING

by NELSON E. COOK

▲ FROM the standpoint of the coating operator, the cleaning of the base steel prior to coating is probably the most important step in the total process. It is a well recognized fact that the quality of coatings and of the finished coated products depends, to a great extent, on the cleanliness of the base to which the coatings are applied. It is also a well recognized fact that, in the past, we have not attached enough importance to this phase of the process.

There are many products and contaminants which must be removed before coating, among them rust, different types of heat scale, grease, oil, carbon smudge and other burned oil products, dirt and dust, alkalies and soluble iron salts and other residues from pickling and cleaning processes, and residues of wetting and emulsifying agents and their products which are formed in cleaning operations. Before the advent of cold reduced material, the problem of cleaning was troublesome enough, but with good pickling and cleaning practices of a rather simple nature, and with a good share of luck, fairly satisfactory coatings were rather easily made. The introduction of the cold rolling process, with the incidental problems brought about by the oils used in rolling and the products which these oils form in subsequent processing, made the requirements for thorough cleaning more difficult, and these problems have not yet been completely solved. There will be almost unlimited demands for quality coated products in the postwar markets and, since it is quite obvious that it is highly desirable and, in fact, necessary, that the industry use cold reduced material, it is imperative that we solve this problem in the not too distant future.

Why does the coating operator need clean sheets?

Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pa., Sept. 25-27, 1944

The answer to this question is very simple. Coatings, whether they be metallic, such as lead, tin, terne, or zinc, or whether they be organic, such as paints or lacquers or enamels, or whether they be special chemical treatments such as have been used extensively for many war products, are applied for some specific purpose, the purpose generally being to give added protection to the steel base. The coating operator is interested not only in producing a quality product, but, more important, he should also be interested in making the most efficient use of the coating material. Each type of coating material has fairly definite properties such that for any standard unit of thickness a rather definite amount of protection may be expected. It follows, then, that if the coating operator is to make the most efficient use of the coating material, certain requirements must be met. First, the coating film should be as continuous as possible, with the minimum of porosity, since protection is not realized at the points where the bare steel is exposed, except in the case of some metallic coatings, notably zinc, where the sacrificial properties of the metal may, for a short time, provide for some increased protection due to the covering over of the exposed areas. Second, the coating film should be as uniform in thickness as possible. Obviously the total value of the coating film is only as good as its thinnest area, and, while uniformity of thickness of the coating film does not depend alone on the cleanliness of the steel base, still the cleanliness of the base has much to do with uniformity. Third, the coating films should adhere to the base metal as tightly as possible. Coating films adhere to the base metal in several different ways. In some cases chemical combinations are made with the steel base; in other cases, notably in the hot metallic coatings, alloys are formed between the coating and the base metal. While complete cleanliness of the base metal probably does not guarantee tightness of the coating film in all cases, still it is one of the most important contributing factors. If for no other reason than that of making the most efficient use of coating materials, we should give much study to the cleaning of the base. To illustrate this point let us consider the process of hot dipping articles in zinc with extremely heavy coatings. A good example is a water tank, on which is put a zinc coating of approximately 8 ounces per square foot, or 4 ounces per square foot per side. If this article is not thoroughly cleaned before coating, and if there remains residues of foreign material on the surface of the steel, then, while the appearance of the coated article is such as to seem to be satisfactory, there will be weak spots in the coating where the zinc has simply bridged over the foreign material. In extreme service these weak links will soon fail, making the article unfit for further use for which it was intended. The point is this: If the tank had been uniformly and continuously coated with a coating film of zinc of 4 ounces per square foot per side, it would last many years in service. But the weak links in the coating fail very soon and, since the total coating is only as good as its weakest link, we might just as well have applied an average coating approximately equal to the thinnest area. And, providing this thinner coating was spread uniformly, we would get the same approximate protection. This illustrates the inefficient use of coating material. Several large steel producers have announced preliminary test results of research along these same lines, in which they have proved that, due to coating on unclean surfaces, the effectiveness of the coating film has been greatly reduced.

What degree of cleaning does the coating operator need? This is a much more difficult question to answer, since we seem to have no definite yardstick, at the moment, with which to measure cleanliness. Many specifications, especially government specifications, indicate that material shall be free from rust, oil, dirt, etc., but they do not specify methods for accomplishing the results, nor do they establish any common testing procedure for determining whether or not a surface is chemically and physically clean. Certainly we cannot use visual inspection as a test, for such a method proves very faulty. We cannot use the common "No water break" test to determine the cleanliness for it is possible to have a sheet covered with smudge which also gives a positive "No water break" test. Some work has been done on testing for oil contamination after cleaning, by observing fluorescence under ultra violet light, but such methods of testing have not yet proven of much value. Therefore, we are still searching for methods which will give us positive tests of cleanliness. Most of our present testing is necessarily done after the product is finished, rather than on the material before coating. In electrolytic coatings we can determine cleanliness, in a rather crude way, by observing whether or not the coating "takes" on the base steel. Generally if the sheet is not clean the electrolytic coatings will just not cover the steel base. But, with many improvements in the methods of electroplating, this is not now always true for, in some cases, it is possible to apply electrocoatings over unclean material, in which case the material passes visual inspection but will not be satisfactory in service. In most hot metallic coatings, fluxes are used as a first step in the coating process. These fluxes are, in themselves, partial cleaners, but not capable of doing a complete cleaning job. Unfortunately, in most hot metallic coatings, it is possible to cover up and bridge over unclean spots in the sheet, with the result that the finished material looks satisfactory in visual inspection, but will not stand up in service. In applying organic coatings, the steel base must be absolutely clean of all foreign materials in and on the steel base, and must also be free of any residues from cleaning processes which would react subsequently with the coating material to lessen its protective value. In the case of some painting and lacquering, the coating film is not applied directly to the steel base, but to an insulating chemical layer, in which case it is necessary to clean the steel surface sufficiently to effectively take the insulating film. It is obvious, then, that there are different degrees of cleanliness needed for different types of coating processes. It is also obvious that, until we are able to find some definite, positive, method of testing the cleanliness of a steel base sheet prior to coating, the coating operator will be unable to answer definitely the question as to the degree of cleaning needed, and this method of testing, to our knowledge, has not yet been found.

How does the coating operator propose to get clean sheets? We do not believe the coating operator is particularly interested in just how or where the cleaning is done, but he is interested chiefly in simplifying the

present procedures to the point where he is confident that he is doing the best coating job possible. The coating operator is confused by getting material for coating contaminated by such a variety of materials that he does not know how to proceed in the cleaning process. He is further confused in having hundreds of materials available for the pickling and cleaning processes, all of them having merit for specific uses, but most of which can only be used by the cut and try methods, since the coating operator does not always know just what materials and contaminants are to be cleaned from the steel. He is still further confused by not having any positive test method to indicate the degree of cleanliness of the product after cleaning. There are many types of cleaning and many processes and combinations of processes which may be used. There are many varieties of acid pickling, vapor degreasing, blasting, alkali cleaning, electrified or not, and many types of chemical cleaning treatments, all of which may be used singly or in combination to accomplish desired results. There has been some progress made in attempting to provide means for doing the complete cleaning job in one operation, as, for example, in several types of controlled atmosphere annealing, and in the recent development of gas pickling.

Insofar as the coating operator is concerned, the choice of the type and degree of cleaning should be based on the following considerations:

First, the cost angle is very important. The coating operator is usually dealing with small pieces of material, or relatively small tonnages of material. In attempting to clean this type of material by some combination of processes, the cost is naturally much higher than when the major part of the cleaning is done at high speeds and in larger units. Therefore, looking at the overall total cost of the finished product, the coating operator believes that a saving in cost would be realized if the material were completely or almost completely cleaned at the source.

Second, the coating operator believes that more efficiency would obtain if the material were cleaned at the source, where it could better be determined just what it is necessary to clean, based on the processes of producing. This would tend toward more efficiency in the cleaning operation, and better standardization of the product.

Third, while some of the newer processes such as gas pickling, etc., are designed in such a way as to be an integral part of the coating units, it is not generally good technical procedure to attach too complicated a cleaning unit to a coating operation, especially if the coating operation is a continuous or semi-continuous one, for the simple reason that there is always a possibility of developing trouble in the cleaning end of the operation which would slow down or tie up completely for some time the more important coating unit proper. Therefore, the coating operator believes that steel should come to him in such condition that either no cleaning operation is needed before coating, or certainly no cleaning operation that is too complicated and involved in its workings.

Fourth, the coating operator is usually interested in obtaining cleaned sheets which have not had their physical properties altered in the cleaning process and, for that reason, he believes that there should be some cleaning procedure devised which would accomplish this at the source in such a manner that any slight degree of cleaning which he might be required to do just prior to coating would not alter the physical properties further.

The coating operator knows that he should have clean sheets. It is not his intention to pass on this responsibility for cleaning to someone other than himself. But he does know that he cannot solve the problem himself, and he believes that such slow progress has been made in its solution because of a lack of mutual understanding of the problem by all those who should be concerned. He believes that the only certain method for its solution is in further concentrated study by the steel producers, cleaning technicians, suppliers of equipment, and the coating operators, as a group. When the real problem is mutually understood, there is no doubt but that the processes of cleaning will be greatly simplified and standardized, and that better quality coated products will be produced at a satisfactory cost.

Cleaning Steel FOR SUBSEQUENT COATINGS

by J. J. DUFFY, JR.

▲ WITH all the criticism and discussion that postwar planning has brought to us, there seems to be a common artery in all the propoundings: When peace is restored, we are going to need more of low cost, better quality commodities. To the steel industry, I would interpret this to mean:

1. Increased rate of production.
2. Lower costs.
3. Better quality.
4. Improved appearance.

Cleaning is one of the most significant operations in obtaining all of these objectives. The choice of proper chemicals for the cleaning bath is just as important as the selection of equipment and the technique of applying the various finishes. I need stress no further the significance of the cleaning process in the steel business because our experience teaches that the steel industry, as compared with other industries, is much more conscious of and, we believe, has properly evaluated its importance. The steel mills are unique in their appraisal of the importance of cleaning problems. Qualified, trained men are generally assigned to the task of overseeing the cleaning operations. This is as it should be and really pays dividends. It certainly tends toward deriving the maximum benefit from the chemicals used.

GENERAL THEORY

There are three major forces by which soil can be removed from steel surfaces: chemical, physical and

mechanical. Specific examples of each of the foregoing classes are:

Chemical means — Saponification, neutralization and other chemical reaction combination.

Physical means — Emulsification, solubilization (solvency).

Mechanical means — Agitation (movement of work or solution and electrolysis) and abrasion (brushing, sand blasting, etc.).

To our knowledge, there is no known chemical substance or method which employs the maximum desirable features of each of these three forces. A properly buffered, alkaline cleaner in hot water solution, used as a soak and in combination with electrolytic current has proved very satisfactory. There is still, however, much room for improvement. There is one obvious shortcoming of an alkali when properties of this kind are reviewed. An alkaline cleaner has very little true solvent power. It functions principally through emulsification, saponification and agitation.

Recent studies directed toward incorporating in the cleaning process more of the solvent properties, outlined previously under "Physical Means," have shown some rather encouraging results. Outstanding among these is the use of the solvent emulsion type cleaner. As far as the steel industry is concerned, these studies are still in progress and no definite conclusions have been reached.

Many of us formerly believed that any hot alkaline solution would in time remove all the contamination from a metal surface. However, our experiences have shown this belief to be false. One reason is that the soils with which we are concerned are changing in chemical composition and other physical characteristics which effect their ease of removal. Obviously, the suppliers of these coolants, slushing oils, bearing oils, thread cutting oils, preserving oils, etc., cannot give primary consideration in their development work to the ease with which their product may subsequently be removed. Quite naturally, their first objective is to design a product which gives better lubrication, operates at lower temperatures with increased stability, etc. Many revisions in lubricants have been made as a result of the shortage of critical materials, and these changes have magnified the job required by the cleaner. A substantial number of these compounds stubbornly resist normal alkaline cleaning and frequently a solvent type or an acid type pretreatment is desirable in order that the alkali may exert its maximum cleaning power.

Solvent emulsions for use in metal cleaning were developed in the early 30s, and are gradually being recognized as definite aids to the cleaning processes of many metal finishing industries. Indicated benefits from the use of the solvent-alkali combination are as follows:

1. A cleaning solution which is less vulnerable to variations in:
   (a) type of soil,
   (b) water conditions,
   (c) equipment used, and
   (d) time of immersion.
2. Quick, effective removal of oil and smut.
3. More satisfactory cleaning of sheet after coating such as hot dip tinning.

SOLVENT EMULSION

The solvent emulsion cleaner, of course, is always used in conjunction with standard alkaline cleaning. Its application does not represent a radical departure from established cleaning procedures — straight alkaline cleaning is still the final cleaning. It merely requires the addition of another chemical to the cleaning process which supplies some features which are at present lacking in the alkaline bath.

The exact mechanism of solvent emulsion cleaning is not clearly understood. The preparations themselves consist of soaps, blending and coupling agents, and emulsifiers extended in a grease solvent. When in use, soap is dissolved in the water and dispersed in the solvent, all of which are held together in emulsified form. The solvent portion wets out the solid particles in the soil. Some of these particles may repel water and alkali alone. Thus, opportunity is afforded for all types of soil particles to become saturated or wetted and thereby more easily removed by use of the penetrating, dissolving and emulsifying powers of this solvent-alkali combination.

WATER CONDITIONS

Water is the one raw material used in the cleaning process over which we have little control. This one factor distinguishes the industrial chemist from the water chemist, who must deal with constantly changing raw materials. I cannot stress too deeply the importance of choosing the chemicals for cleaning with a definite eye to the type of water available. Unless all water is treated this may vary from season to season in certain localities, and consideration must be given to this fact.

Variations in the water supply might very well have an immediate and direct bearing on the following important phases of the cleaning operation:

1. Efficiency in cleaning power.
2. The adherence of coating.
3. Appearance of coating.
4. Cleaner consumption.

Recent developments in the phosphate and synthetic wetting agent fields have aided us tremendously in overcoming some of these water difficulties. While their application is limited at the present time, I am sure that in the postwar era, when these products are more available, they will be more generally used for this purpose. We have also had some evidence that the solvent-alkali combination aids considerably in overcoming this difficulty with the ability of the solvent-soap mechanism to surround and deflocculate hardness particles.

CONTROL OF CLEANING BATH

Because of rigid quality and economy requirements, the need for absolute chemical control is obvious. Compare the cost of the finished product when cleaning is not good with the costs when cleaning is satisfactory and you will find, if your accounting is good, a disturbing difference — yet the cost of cleaning chemicals used is approximately the same in both cases. This might be done quite easily by simple acid titrations at fre-

quent intervals during the day — approximately one every four to eight hours. Expedient methods are now available, but further work has yet to be done on an absolute, quick method of control for alkali emulsions.

SOAK VS. ELECTROLYTIC CLEANING

Some degree of controversy exists in the steel industry on the subject of various methods of electrolytic cleaning together with its contrast to soak (or non-electrolytic) cleaning. This has prevailed in the electroplating industry for some years and only recently is there some semblance of agreement. Practice will vary from one mill to another, depending upon equipment, production, personnel, and type of soil encountered. The important fact to remember here seems to be that agitation is necessary. Whether it comes as a result of the convection currents of the steam coils, movement of the strip, or from other means of agitation is of no serious consequence. Our experience has been in favor of the use of electrolytic cleaning in spite of some installations where successful cleaning is done without its aid. There is a need, if current is used, for the impression of sufficient potential so that adequate gassing is provided. A current density of 35 to 40 amp per sq ft would seem to be the minimum in order to justify the costly installation which the use of current requires. The combination of direct current first and then reverse appears to have accepted favor. I believe this is due partly to the balancing out or neutralizing of the disadvantages of each current. As you know, when direct current is used, the work being the cathode, certain "plating out" action is realized. With the use of reverse current, less gassing takes place and the danger of oxidation is ever present.

SERVICE

The cleaning of metal before coating entails many variables. Thus, it is evident that the responsibility of the cleaning compound supplier is great. It behooves him to acquaint himself with how the variety of his products may be properly applied under any specific or varying conditions. It is imperative that he have an overall picture of the industry and benefit by this experience which should be most helpful to those confined to one scene. Furthermore, he should have at his disposal the results of extensive and thorough research and development on the application of chemicals to cleaning.

"Swivel chair" recommendations are not only unwise but dangerous. Conditions should be observed in the plant or mill, and in permitting this to be done the steel industry (again in contrast to other industries) has been very cooperative.

In conclusion, I think I am reasonably sound in stating that there is no one chemical or chemical cleaning process which represents a panacea. The specific conditions existent at the mill under consideration must be thoroughly studied and the chemicals applied to cleaning chosen accordingly. Until the day when some research chemist develops such a product, all of us must continue to give serious consideration to the cleaning operation.

Electrolytic CLEANING LINES

by J. I. GREENBERGER

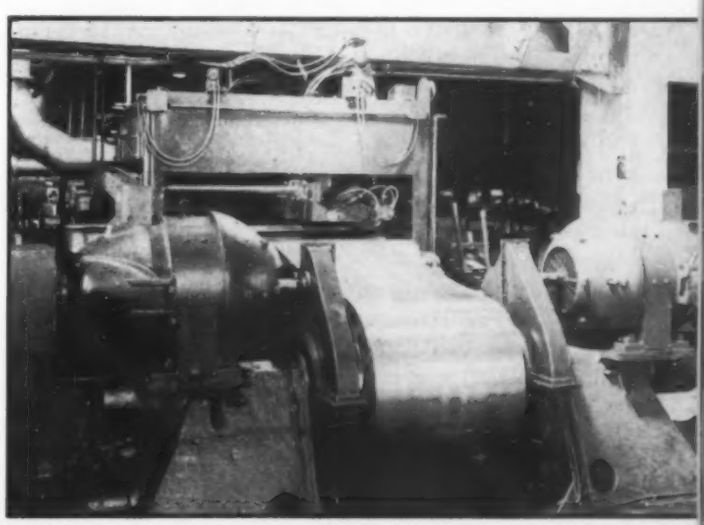
▲ SUCCESSFUL coating of strip requires proper cleaning at the proper stages. It has been established that unless the rolling oils and foreign matter are carefully removed from the strip prior to annealing, subsequently coated plate will be spotty and of inferior quality. The electroplating industry has long known the necessity of chemically clean stock as a prime requisite for successful plating and the recent advent of electrolytic tinning and electrolytic galvanizing lines in the steel industry has made it necessary for the steel mills to reexamine their practice in the light of the electroplating industries' experience.

Development of continuous tandem cold rolling and reversing mills created a specific cleaning problem. It was found that the high pressures of cold rolling forced the rolling oils into the pores of the strip, which, when

Figure 1 — General view showing an installation of four electrolytic cleaning lines.

▲

Figure 2 — Entry end of electrolytic cleaner using a double drag generator type uncoiler.



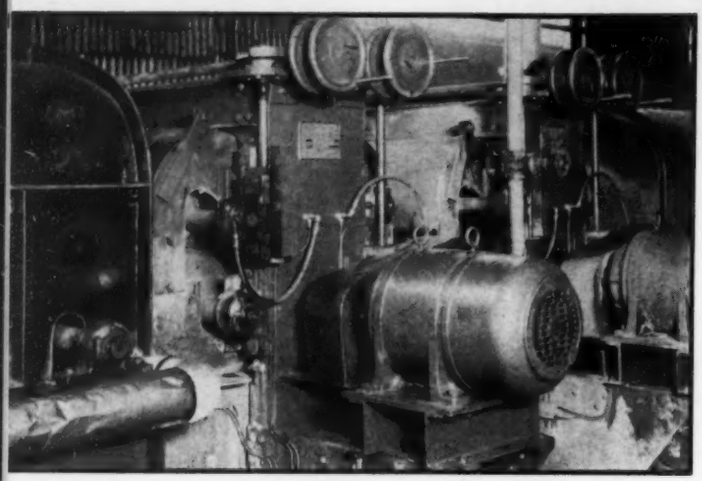
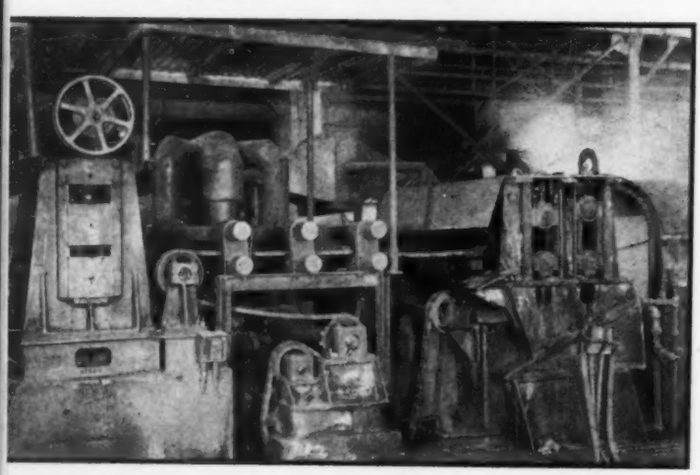


Figure 3 — In the scrubbing unit, nickel silver brushes are used, with rubber covered rolls backing up the other side of the strip.

▲

Figure 4 — This view shows double wringer rolls on hot rinse tanks, hot air dryer, master pinch rolls, and the end of the full-length threading device.



added to the normal amount of mill "pick up" of foreign matter created undesirable operating features. During subsequent annealing, the rolling oils would carbonize, resulting in badly stained strip. The closely adherent grit and foreign matter would mark the work rolls of the skin pass mills, resulting in a characteristic series of fine marks familiarly known as "cat's paws," "mice tracks," etc., making frequent roll changes necessary to get proper strip surfaces. The adherent foreign matter resulted in porous tin plate and excessive menders and strippers. Development of the electrolytic cleaning process as an intermediate stage between the cold rolling and the bright annealing corrected these undesirable features.

The slow speed of various "still" solvent and emulsion type cleaners, as well as their inability to remove closely adhering foreign particles from the strip surfaces, eliminated these processes as possibilities for tin plate cleaning.

As a first cleaning process, there was developed a caustic dip line combining chemical and mechanical cleaning and consisting essentially of a caustic dip tank, scrubber, and rinses. These lines were limited to speeds up to about 300 fpm and the quality of cleaning was apparently satisfactory. As mill speeds and tonnage increased, and as tin house specifications became more rigid, high speed electrolytic cleaning lines, combining electrolytic, chemical, mechanical, and thermal actions, were developed.

The electrolytic cleaning cycle, as developed for strip applications, consists of four distinct phases:

1. Primary excess oil and dirt removal to take off the bulk of the surface oil and foreign matter.
2. Electrolytic cleaning to remove the oil and foreign matter from the pores of the metal.
3. Scrubbing and rinsing to remove loose surface scum carry-over.
4. Drying of the strip.

Coordination of suitable mechanical and cleaning equipment to successfully feed the strip through the proper cleaning cycle with a minimum of handling and down time was a gradual growth until the present time, and now electrolytic cleaning line speeds of 2000 fpm and over are accepted practice.

Tin plate electrolytic cleaning lines have been designed to handle centerless coils from 16½ in. to 20 in. inside diameter, up to 48-66 in. outside diameter, in widths from 16 in. to 38 in., and in gauges from No. 16 to No. 38. Coil weights range from 6000 lb to 30,000 lb. Line speeds are a function of the required production.

Electrolytic cleaning lines have also been developed for wider and heavier plate, covering the sheet mill range. Aluminum and other nonferrous cleaning lines are also available.

Experience on the various electrotinning and electrogalvanizing lines indicates that the best possible cleaning following the cold reduction is necessary to insure properly prepared base plate. There is sufficient handling after the annealing operation in the temper rolling and possibly side trimming operations to conceivably permit pick up of foreign matter before the final coating, so it seems advisable to include an electrolytic cleaning cycle in the electrotinning and electrogalvanizing lines.

A MODERN *Strip Pickling Plant*

by LANE JOHNSON

▲ IN the production of electrolytically coated steel by the modern continuous strip method, it is axiomatic that unless absolutely clean strip, having properly etched surfaces, is delivered to the plating unit, the production of prime quality plate is seriously reduced, if not rendered altogether impossible.

As far as is known, the earliest plating practice recognized this precept and in all of the continuous electroplating installations which have been made in recent years, provision has been made for a final acid etch treatment immediately prior to the actual plating.

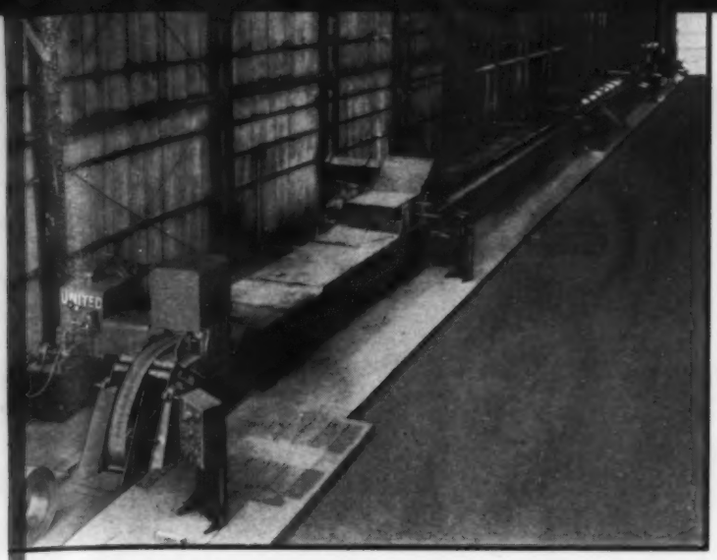


Figure 1 — General view of 22½ in. semicontinuous strip pickler installation.

A simple chemical acid etch employing sulphuric acid is usually employed although some use has been made of other chemicals and in isolated cases, the etch has been electrified. Some of the factors governing the selection of type of equipment used are:

1. Degree of etch required.
2. Line speed.
3. Space considerations.
4. Chemicals employed.
5. Maintenance requirements predicted.

Black pickling involves the handling of hot rolled strip for the purpose of removing by chemical means the several iron oxides from its surfaces and for the production of scale-free stock suitable for succeeding processes, the principal of which is cold reduction.

Black picklers of many types and designs have been employed for processing sheets, although the breadth of the field has been considerably reduced where pickling of coils has been required. Notable among the coil picklers are tub picklers, rotary coil picklers, conventional continuous picklers, and relatively lately, the semicontinuous pickler.

The semicontinuous type strip pickler was originally developed with the requirements of certain smaller members of the industry in mind and has, after several years of successful operation in the several plants in which installations have been made, proved so satisfactory that a prominent place in postwar pickling planning is predicted for it.

The conventional continuous type strip pickler involves joining successive coils in order to provide continuity; it requires looping pits to permit storage capacity so that time required to join without slowdown in the processing zone is provided; and it must include shearing facilities for parting after pickling so that individual coils can be delivered for future rolling or other processing.

The semicontinuous type, on the other hand, takes advantage of the inherent stiffness of flattened hot rolled strip and each coil is processed individually by

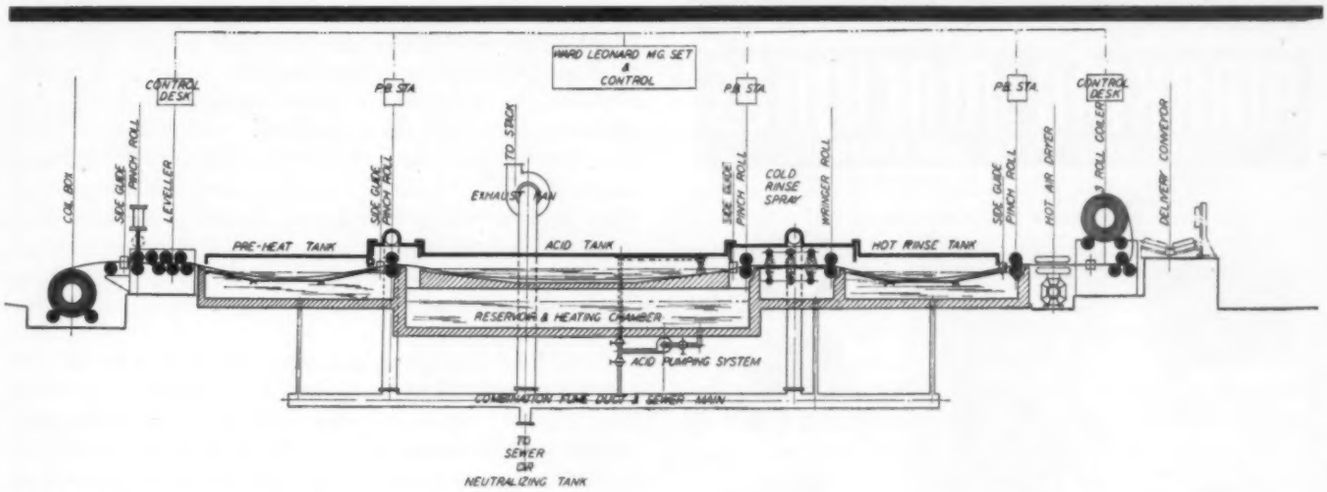


Figure 2 — Schematic general arrangement of semicontinuous pickler.

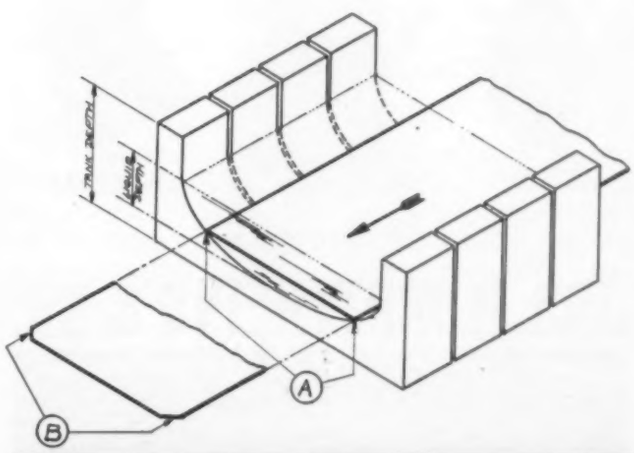


Figure 3 — Sketch showing how contoured tank bottom supports strip in semicontinuous pickler.

Without the black pickler, however, the very existence of the entire flat rolled industry could not have been. A general statement can be made that complete removal of rolling scale not only actually permits the practice of the art of cold reduction, and synonomously the ultimate production of electroplated products, but also that the degree of removal decidedly affects the individual efficiencies and economies of each of the processes involved.

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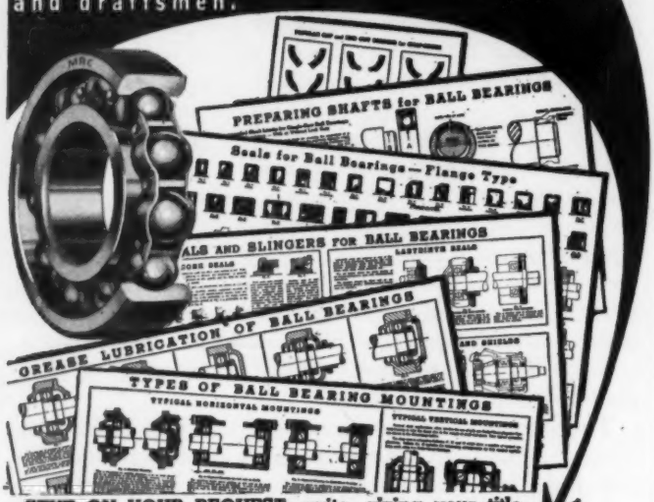
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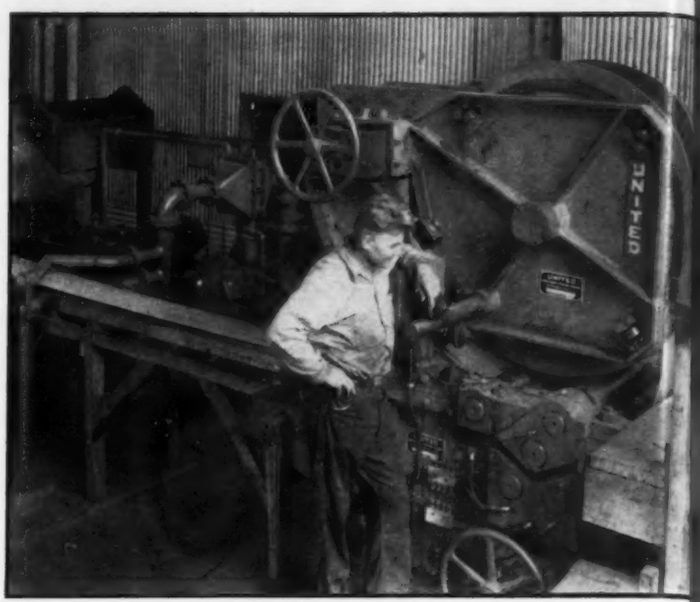


Figure 4 — Discharge end of 22½ in. semicontinuous pickler, showing dryer and 3-roll upcoiler with oiling device.

pushing through the various tanks, pinch rolls, etc., thus eliminating the need for joining equipment, looping pits and shearing facilities and resulting in substantial savings in investment and space required.

A hot rolled coil, the corners of the leading end having been clipped to facilitate guiding, is placed in a coil box and the leading end fed into the bite of quick-opening pinch rolls. The pinch rolls feed into a roller leveler, which properly flattens the strip and acts as the main push unit to feed it into a preheat hot water tank, which elevates the strip temperature to pickling level, and then into a synchronized pinch roll, which in turn feeds into the first acid tank. Successive pinch rolls feed into as many acid tanks as are required to meet the production. With pickling completed, the strip is rinsed first in a cold power spray, then in a hot dip tank. After passing through a hot air dryer, it is then recoiled in a 3-roll upcoiler, and when kicked out, is ready for further processing.

Combination fume duct and sewer serves all hot tanks for removal of fumes and all tanks as main sewer line. All acid tanks are provided with a specially contoured bottom lining so that the strip is supported on its edges, thus permitting the bottom to be pickled as equally and effectively as the top; new acid is continually presented to the strip by means of pump circulating systems; temperature is automatically controlled and unusual attention paid to reducing the heat losses to a minimum.

In short, every effort has been devoted toward evolving a pickling plant to meet the demand for an installation involving lowered investment cost, to meet production requirements in spite of a lowered available manpower potential, to permit operation in a satisfactory and effective manner, and to attain cumulatively an appreciable reduction of overall operating costs.

Experience and satisfaction accruing from existing installations seem to testify to the accomplishment of these goals.

SOMETHING NEW IN

Remote Control

. . . . setting forth a new system of remote control which has been widely used in combat equipment and which has wide possibilities for industrial application . . . .

by T. J. KAUFFELD

CONSULTING ENGINEER

NEW YORK, NEW YORK

▲ OUT of this present war are coming technological developments which will greatly affect peacetime industry. Remote control — or motion controlled from a distance — promises to be one of these outstanding developments.

Probably the most fascinating and yet least well-known development in this field of remote control is a system invented by Michel N. Yardeny to suit the special requirements of the United States Government for special uses in conjunction with combat equipment. While at this time the limitations imposed by wartime restrictions are responsible for a lack of specific engineering information being available, nevertheless this article is inspired by a desire to stimulate engineering thought in the steel industry as to the practical application of this versatile, accurate and relatively inexpensive piece of equipment which, although combat tested, is now making its debut in other industrial fields, such as:

Industrial equipment — Control of any function requiring accurate adjustment or setting from a remote point, such as register and alignment of printing equipment, paper making machinery, chemical processing equipment; speed and feed changing mechanisms; machine tool operation; furnace and oven temperature regulation; control of hydraulic pressure systems, pumps and valves; power house and substation unit controls; engine fuel supply regulation, and many others.

Electronic devices — Control of mechanical action or motion requiring torque: band-changing switches, antenna tuners, transmitter controls, receiver controls and direction finder controls.

Marine apparatus — Control of engine and power plant elements; steering controls; heating, lighting and ventilating control; control of apparatus from a remote control tower.

Aircraft — Control of trim tabs and other secondary flight surfaces; control of power plant accessories, pumps and valves of hydraulic systems, air and oil cooler shutters; cabin heating and ventilating; accurate positioning of cargo doors, hoists and the like.

This new remote control system comprises an electromechanical device by means of which an operator is able to control a motor-driven mechanism at a remote location in such a manner that the controlled unit will assume a desired position with extreme accuracy. As an illustration, use of this control permits an operator to control the rotation of a shaft connected to an electric motor and located out of sight and hearing to any desired angle or angles, within one or many revolutions, with an obtainable accuracy of 1/100 of a degree of rotation. An important feature of this particular sys-

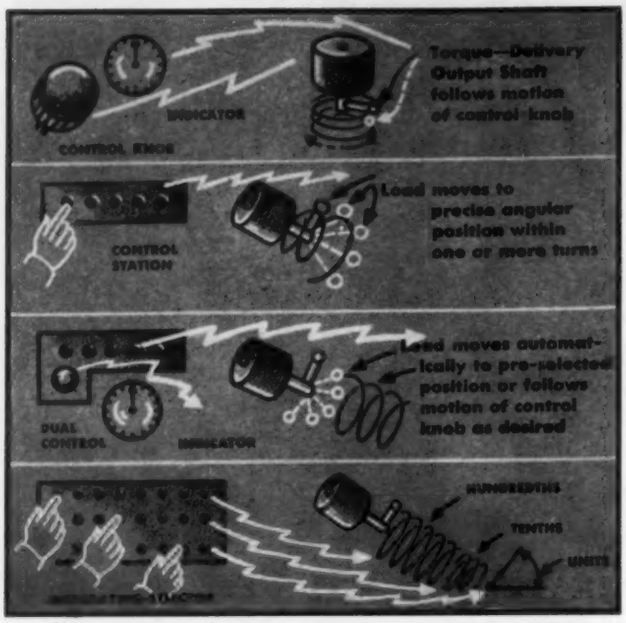

Torque—Delivery Output Shaft follows motion of control knob
INDICATOR
CONTROL KNOB
Load moves to precise angular position within one or more turns
CONTROL STATION
Load moves automatically to pre-selected position or follows motion of control knob as desired
DUAL CONTROL
INDICATOR
HUNDREDTHS
TENTHS
UNITS

Figure 1 — Sketches illustrating the four basic types of this control. From top to bottom, respectively, continuously-variable, multiturn selector, dual and integrating selector.

tem is the maintenance of accuracy throughout any number of operating cycles.

Basic components of this new remote control system are a torque delivery unit — that is, an electric motor which operates any kind of apparatus — and a control transmitter. These two devices may be located any reasonable distance apart.

Any desired modifications in torque delivery are obtainable. Movement of the output shaft of the torque delivery unit is angular and therefore, where only rotary movement of an apparatus is to be controlled accurately, the unit can be installed in alignment and coupled to the apparatus requiring control. When the controlled apparatus functions with a reciprocating or push-pull movement, the use of bell-cranks and mechanical linkage can readily convert the controlled rotary motion of the output shaft into a rectilinear action. Coupling of the output shaft to a screw jack, or to a lead screw equipped with one or several traveling nuts, is still another modification that offers unlimited application possibilities.

Remarkable accuracy to 1/100 of a degree of rotation, the ability to transmit torque, simple construction coupled with dependable operation over a long period of time, inherent accuracy practically unaffected by temperature changes, extreme vibration, impact shocks, or the wear and tear of severe usage all tend to make this system of remote control particularly adaptable to the steel industry.

In the present stage of development and application, there are four basic types of remote control by the new system, applicable to a wide range of equipment control. Requirements for remote controls with different characteristics can also undoubtedly be developed, employing the same principles of operation. The four basic types of remote control are as follows:

Continuously-variable control — For positioning a load accurately within one or many revolutions, at the will of the operator, the position of the controlled shaft being indicated, at the point of control, by a position-indicating instrument or dial.

Multi-turn selector — For positioning a load accurately in any one of a desired number of preselected positions, within one or many revolutions, controlled without regard to sequence by a remotely located switch or push-button station.

Dual control — A combination of the two preceding methods, providing variable manual and automatic preselection in one instrument. The assembly includes a position indicating dial to provide the operator with a visual indication of the controlled shaft location.

Integrating selector — For positioning a load accurately to any one of a vast number of positions with a relatively small number of remotely located push-buttons arranged for integration. The selector mechanism consists of several motor-driven components arranged for a cumulative effect or totaling of selected subdivisions.

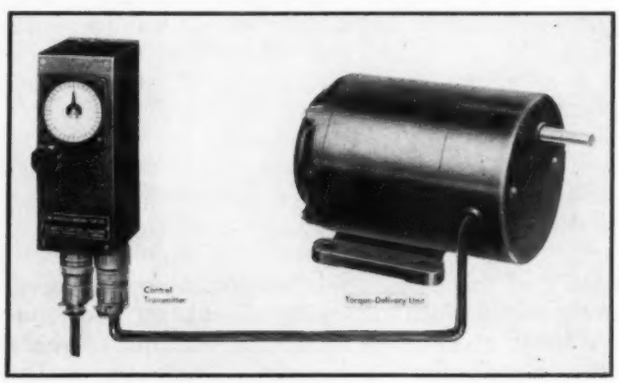
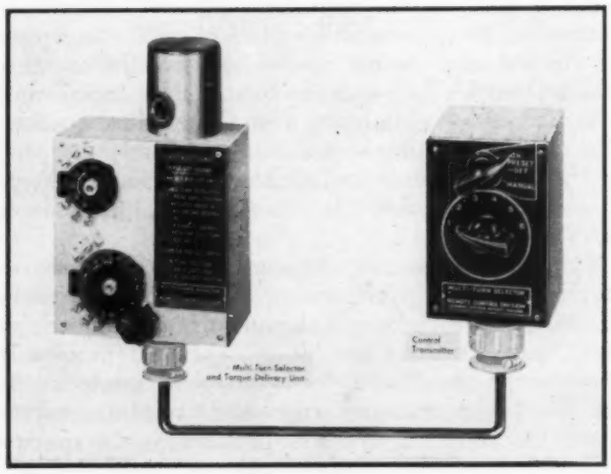


Figure 2 — Continuously-variable precision control.

▲

Figure 3 — Multiturn selector.



CONTINUOUSLY-VARIABLE CONTROL

This is an electromechanical, nonsynchronous, follow-up remote control with a repeat back indicator for positioning from a remote point the controlled shaft governing considerable torque or load with exceptionally high accuracy. The operator is able, by turning a knob on the control transmitter, to control the position in rotation of the output shaft of the remotely located torque delivery unit.

An indicating dial on the control transmitter, electrically connected to the output shaft of its companion unit, shows the operator the position of the controlled shaft or load throughout the operation. This visual indication enables him to know what position the load is in and thus permits him to position the load to any point he desires. The accuracy within which this position may be read varies with the needs of any given application and with the type of return indicating instrument used. Dials can be calibrated to indicate percentages, degrees, length of movement, number of revolutions or whatever the particular application calls for.

The unique performance of the control mechanism permits the operator to adjust the position of the load shaft to a precision as close as 1/100 of a degree of arc. The ultimate accuracy in the position of the load which is thus controlled will of course depend directly upon any intermediate gear reduction.

The essential element of the continuously-variable remote control is the control transmitter as illustrated in Figure 2. The housing encloses the controlling mechanism, position indicating instrument and necessary electrical connectors. The small reversible motor that actuates the control mechanism and the motor that powers the torque delivery unit are not synchronized. Any standard reversible motor, either a-c or d-c, may be employed.

Any movement of the control knob causes a responding but nonsynchronized movement of the output shaft in the torque delivery unit. When the knob is turned to the right, the shaft turns to the right and vice versa. The instant the knob stops, the shaft stops. If, however, rotation of the output shaft is desired over a considerable number of revolutions, the knob is given a quick, broad twist, the hand is withdrawn and the knob and shaft continue to turn in unison. As the output shaft approaches the desired position, as indicated by the position indicating dial, the hand again grasps the knob, arresting further motion; instantly the controlled shaft stops as well. Final spotting to a precise position can then be accomplished by "inching" the knob in the desired direction. Coarse or fine adjustment is available at will.

MULTI-TURN SELECTOR

This is likewise an electromechanical, nonsynchronous, follow-up remote control mechanism whereby its connected load may be placed in any one of several

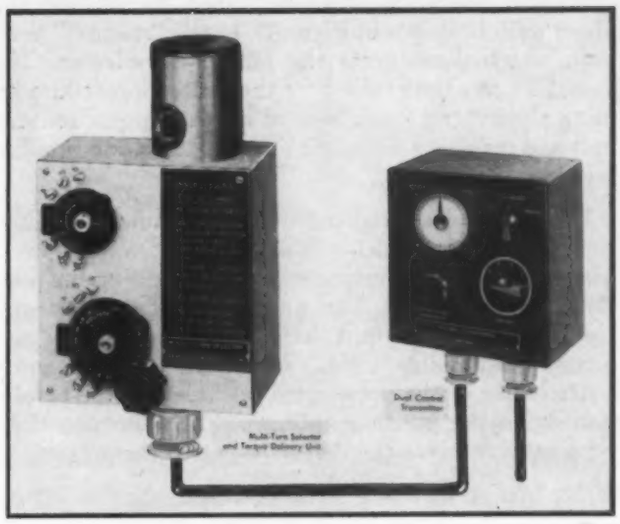
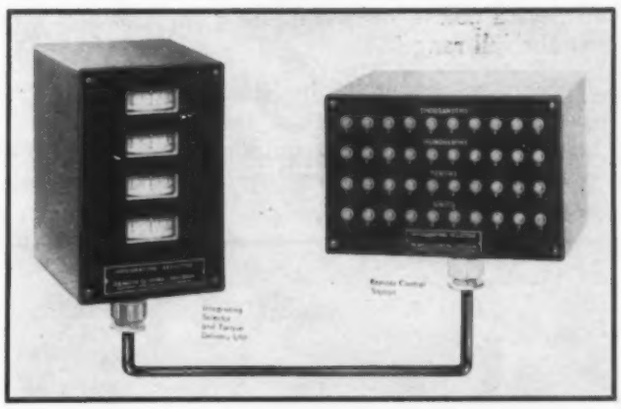


Figure 4 — Dual control.

▲

Figure 5 — Integrating selector.



preselected positions, over one or a number of revolutions. The device illustrated in Figure 3 has adjustments for six positions within 25 turns of the output shaft. Other similar devices can also be furnished for a larger number of preselected positions, or to operate the output shaft through a greater number of revolutions.

The selector is operated from a remote point by push buttons or by a multistation switch. The number of preselected positions governs the number of push buttons or stations. Once the preselector mechanism has been preset to the several desired positions, the control will operate to turn the output shaft to the selector position in the direction of the shortest travel and with an obtainable accuracy of 1/100 of a degree. This accuracy is independent of backlash in the motor drive, vibration or temperature variation. Units can be designed to meet application torque requirements and the control as a whole can be furnished for any kind of power supply for which standard motors are available.

Automatic operation of the multi-turn selector is accomplished by setting the center switch in the control transmitter shown in Figure 3 to the desired position. The output shaft of the torque delivery unit will then turn automatically to the selected position with extreme accuracy.

Manual operation is accomplished by turning the upper switch, shown in Figure 3, to the "manual" position, which disconnects the automatic selector. The operation can thus take over the control procedure by using the control knob located on the torque delivery unit and manually bring the output shaft to the desired position.

Presetting of desired position is a simple procedure. Reference to the multi-turn selector shown in Figure 3 will show slotted adjusting screws surrounding the position indicating dials. The small dial indicates integral revolutions of the output shaft; the larger dial indicates precise positioning within a revolution. Each screw controls one of the preselected positions on the revolution or on the position indicating dial. Turning these set screws revolves the dial adjacent to them.

DIAL CONTROL

By combining the advantages of the multi-turn selector shown in Figure 3 and the continuously-variable control shown in Figure 2, an operator may at his discretion position the load by push button control to the preselected points, or by turning a knob, to any point over the full range.

This is accomplished by employing a multi-turn selector and a dual control transmitter, shown in Figure 4. This transmitter contains both a multistation switch (or optional push buttons) and a continuously-variable transmitter with repeat back indicating instrument. By means of a selective switch, the operator may use either system of control.

INTEGRATING SELECTOR

This type of electromechanical remote control provides automatic setting of the load to a large number of positions by a comparatively small number of push buttons and is shown in Figure 5. The actuating mechanism consists of several motor-driven selectors so arranged that their effect is cumulative and is applied to the controlled load through a single shaft.

In this device the total range is divided into convenient fractions or decimal parts. The mechanism operates to set the load shaft in any desired position, by totaling the selected subdivisions. For example, a control with four selectors could be arranged at decimal intervals as follows:

Selector 1 — 10 parts, each one revolution.
Selector 2 — 10 parts, each 1/10 revolution.
Selector 3 — 10 parts, each 1/100 revolution.
Selector 4 — 10 parts, each 1/1000 revolution.

There would thus be provided a total of 10,000 equally spaced positions covering 10 revolutions of the load shaft, all controlled by 40 push buttons or 4 ten-point switches. Other arrangements can be provided as required, giving more or fewer revolutions, or more fine or coarse divisions.

Special Notice

Because of paper shortages, publication of the bound volume of A. I. S. E. Yearly Proceedings for 1945, which would normally be delivered early in 1946, may be delayed for some time. Readers of Iron and Steel Engineer are therefore advised to save such 1945 issues as they may wish to retain for reference use. These monthly issues will contain all of the material which will subsequently appear in the 1945 bound volume.

To help you select the most efficient fans

Most plant operating men have definite ideas concerning fans and blowers. They want, first of all dependable equipment, second, efficient equipment and third, accessible equipment, so that servicing and maintenance costs can be kept low.

Illustrated here are two new Buffalo Fans and two new Bulletins which give complete data covering them. Read the description below and see if you need these bulletins for your files. No obligation.

The NEW Type "B" Axial Flow Fan ← fully described in Bulletin 3533

was designed to fill the need for a duct-mounted fan for the light duty common to ventilating and air conditioning service, that is for static pressures from ¼" to 1½". Made in nine sizes, up to 48" diameter, in belted-drive and direct-drive models, with or without vanes, the new Type "B" line offers quiet, efficient, reliable performance at moderate cost.

NEW Pressure Blowers and Centrifugal Compressors described in Bulletin 3553 →

These new heavy duty blowers have a wide range of application — handling air for oil or gas furnaces, on high pressure installation in glass, steel and chemical plants, for scale and water blow-off problems, experimental work, etc. They are suitable for pressures up to 4 pounds per square inch. Newly developed rotors give efficient, trouble-free operation. Alloy construction of all or part of each blower is practical.

For Bulletins, Write

BUFFALO FORGE COMPANY

173 MORTIMER STREET BUFFALO, N. Y

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo" "First For Fans"

fans *for* industry

ASSOCIATION of IRON and STEEL ENGINEERS
PITTSBURGH DISTRICT SECTION MEETING

Rolling Mill Symposium

10:00 A. M. — Technical Meeting — Urban Room.

"Soaking Pit Heating"

by R. I. Gumaer, Fuel Engineer, Jones and Laughlin Steel Corporation, Aliquippa, Pennsylvania.

"Design and Application of Rolls"

by A. E. Murton, Manager Roll Department, Continental Foundry and Machine Company, Pittsburgh, Pennsylvania.

2:00 P. M. — Technical Meeting — Urban Room.

"Mill Guides"

by W. F. Hoffman, Assistant Superintendent, Roll Shop, Jones and Laughlin Steel Corporation, Aliquippa, Pennsylvania.

"Cooling Beds and Transfers"

by C. L. Raisig, Mechanical Engineer, Mesta Machine Company, Pittsburgh, Pennsylvania.

"Quality Control Testing of Semi-Finished Bars"

by E. W. Mahaney, Steel Plant Metallurgist, Youngstown Sheet and Tube Company, Youngstown, Ohio.

7:00 P. M. — Dinner — Ballroom.

NOTICE

Because of regulations issued by the Office of Defense Transportation, this meeting will supplant the annual rolling mill program customarily held as a national spring conference.

MONDAY, MAY 14, 1945

HOTEL WILLIAM PENN **PITTSBURGH, PENNSYLVANIA**

Kaiser Builds at Fontana

MOORE RAPID

Lectromelt

THE FURNACE OF TODAY AND TOMORROW

A size "NT" Lectromelt top-charge type furnace for pouring heats of 15 to 20 tons.

MOORE RAPID

Lectromelt

FURNACES

FOR MELTING QUALITY STEELS AND IRONS

With an outstanding record of a war job well done, Lectromelt top-charge furnaces are ready for long and efficient peacetime service. Consult Lectromelt's engineers for complete details regarding your melting problems.

TOP CHARGE LECTROMELTS RANGE FROM 100 TONS DOWN TO 250 POUNDS.

ARMY E NAVY

PITTSBURGH LECTROMELT FURNACE CORPORATION

PITTSBURGH 30, PENNA.

The MODERN STEEL MILL *demands efficient* MATERIAL HANDLING

To achieve its outstanding production records, the steel plant of Kaiser Company, Inc., near Fontana, employs the most modern and efficient material handling methods. Among the equipment used are the two Baker Industrial Trucks illustrated.

Top illustration shows a Baker Crane Truck in the open hearth, preparing fountain for the next tapping by replacing the refractory core.

Illustration at left shows a Baker Fork Truck hauling fire brick in the brick yard. This brick is transported by the truck to the furnaces and soaking pits.

The Baker Material Handling Engineer can help you modernize your handling methods for top production efficiency. Write for Catalog No. 52.

BAKER INDUSTRIAL TRUCK DIVISION
of The Baker-Raulang Company
2166 West 25th Street • Cleveland, Ohio
In Canada—Railway & Power Engineering Corp., Ltd.

Baker INDUSTRIAL TRUCKS

The advanced model **Koppers-Becker** coke-over pla

THESE 90 KOPPERS-BECKER UNDERJET COKE OVENS at Fontana, California, make uniform coke by underfiring with blast-furnace gas or coke-oven gas using Koppers waste-gas-recirculation system.

Although there were many new problems to be met and solved here, a record for speed was set in building this byproduct coke plant. The complete installation includes the materials-handling equipment, the byproduct plant, a benzol recovery and refining plant, and a tar plant.

AN AVERAGE DAY'S PRODUCTION IS AS FOLLOWS:

Coal charged, tons	1,700
Blast furnace coke produced, tons	1,050
Nut coke produced, tons	29
Breeze produced, tons	82
Gas produced, cu. ft.	19,500,000
Ammonium sulfate produced, lb.	46,000
Light oil produced, gal.	6,400
Tar produced, gal.	17,000
Phenol produced, lb.	900
From the light oil:	
Benzol produced, gal.	3,600
Toluol produced, gal.	1,100
Xylol produced, gal.	340
Solvent produced, gal.	180
Non-condensibles, gal.	150
Residue and losses, gal.	450
From the tar:	
Creosote oil produced, gal.	10,000
Heavy residue oils produced, gal.	2,040
Pitch produced, lb.	88,000

The special requirements presented for this plant were met by Koppers engineers, who will be glad to help you solve your own coke-plant problems.

KOPPERS COMPANY, INC., PITTSBURGH 19, PA.

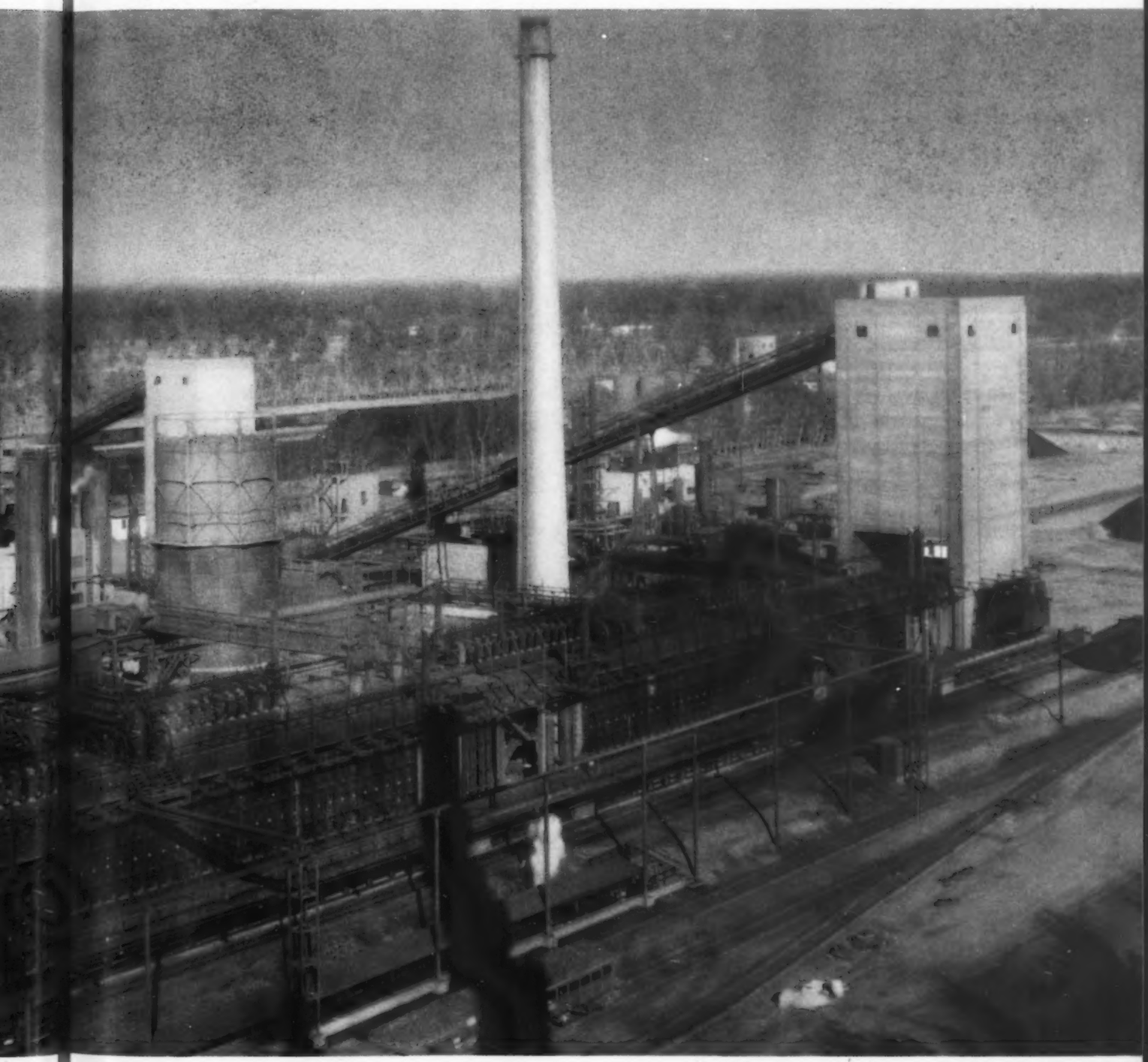
ENGINEERING & CONSTRUCTION DIVISION

KOPPERS

The industry that serves all industry

over plant of Kaiser Company, Inc.

IRON AND STEEL DIVISION



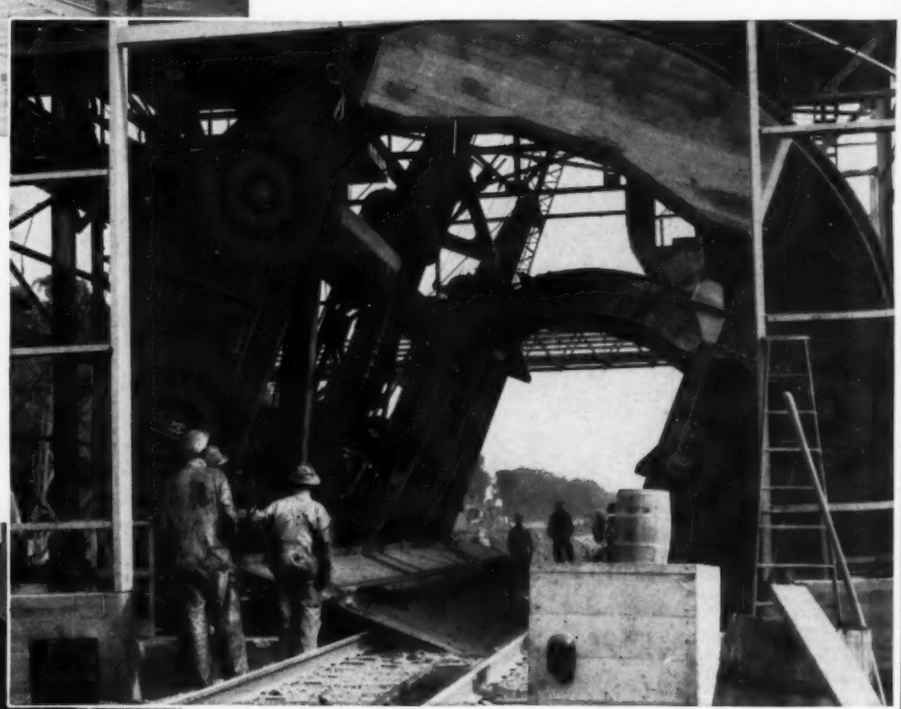
Buy War Bonds—and keep them

How Gondola Cars are Unloaded at Kaiser Steel Plant--

LINK-BELT

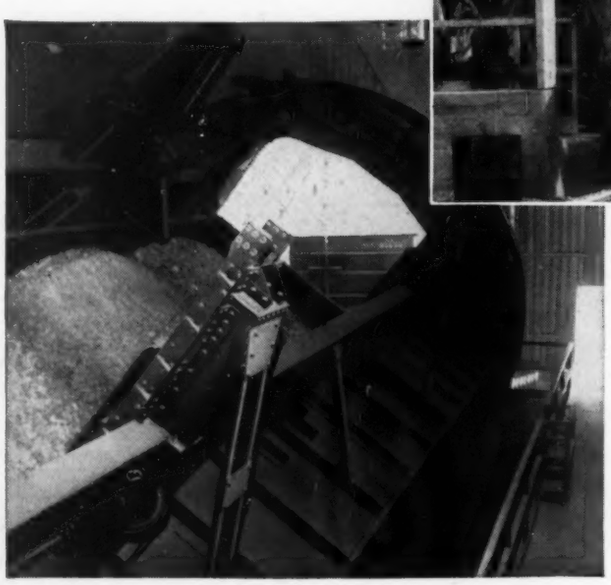
Rotary R. R. Car Dumper Can Unload up to 20 Cars per hr.

• This Link-Belt car dumper in service at Fontana, Calif. and many others like it throughout the country are playing an important part in the battle of production by keeping cars and materials on the move. This unit is capable of unloading all types open-top railroad cars—varying from 26 ft. to 50 ft. long; 6.8 ft. to 12 ft. high; 9 ft. to 11 ft. wide; and with capacities up to 90 tons. The number of cars it can handle in a given time depends upon the switching and track facilities for supplying loaded cars and removing empties. A full cycle of dumping and returning to normal position is accomplished in 1¾ minutes. The whole operation is so simple, automatic and foolproof that unskilled labor can perform it readily; it is completely under control at all times and can be stopped instantly at any point of the cycle. Send for Book No. 1004.



⬆ Above and below: Views of the Kaiser Company's Link-Belt rotary car dumper at Fontana, Calif. This unit unloads cars of ore.

Right: Construction view ➡ taken of same dumper shortly before it was completed for service.



LINK-BELT COMPANY

Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices in principal cities.

5005

Here's the type of 12-tube Ignitron Rectifier that's supplying power for all 14 motors on this merchant mill. These motors have ratings totaling 7,925 hp; the Ignitron Unit, rated at 2500 kw supplies 600 volt, d-c power.

IGNITRON SUPPLIES ALL THE POWER ON THIS 44" MERCHANT MILL

For the first time, the complete power requirements for d-c operation of *all* the motors on a 44" merchant mill are supplied by a mercury arc rectifier. That's the kind of load a Westinghouse Ignitron handles at one of the newest West Coast mills.

Of course, the Ignitron *principle* is not new—Westinghouse discovered it in 1937. Since then, Ignitron Rectifiers have been proved in use by applications in almost every type of industry. The Westinghouse Ignitron Units in service today total over 2,000,000 kw installed capacity.

The Westinghouse Ignitron is ideal for steel mill service—what other type of conversion apparatus can offer such high efficiency over the entire load range? It keeps production rolling despite overloads and short circuits. And it's easily installed. Compact and light in weight, it's built to hold up against dust, corrosive agents and similar mill conditions. There are no commutators, brushes, collector rings or bearings to wear out—maintenance is at a minimum—and operation can be fully automatic.

For more information on how Ignitron Rectifiers will increase your mill efficiency and cut your power costs, write for folder B-3129—or call your nearest Westinghouse representative. Westinghouse Electric & Manufacturing Company, P.O. Box 868, Pittsburgh 30, Pa. J-94671

AND ANOTHER WESTINGHOUSE "FIRST"—

PRECIPITRON

Never before has electronically cleaned air been passed through the turbo-blower that provides air for a blast furnace. Precipitron does the job at this new mill. A bank of 120 cells cleans 90,000 cfm of air—removing all air-borne dirt particles *down to 1/250,000 of an inch in size.* No other method can approach it in efficiency— almost complete freedom from sludge in the blower case means higher operating efficiency for the blower—and blower maintenance reduced to a minimum.

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

ELECTRICAL PARTNER OF THE STEEL INDUSTRY

200 TON ALLIANCE STRIPPER CRANE HELPS SPEED INGOT HANDLING ON WEST COAST

Alliance completed an installation in the Kaiser plant at Fontana, California, of a 200-ton combination stripper and extractor, 61-foot span. This unit, equipped with a retractable bull-nose will strip either the standard small end-up ingots or large end-up ingots with hot tops.

For 43 years, our business has been that of manufacturing machinery to speed steel mill production. Our list of customers reads like a blue book of industry, and you will find Alliance equipment in practically every steel plant in this country and many foreign lands.

The war has re-emphasized our position as "The World's Largest Builders of the World's Largest Cranes." Much of the equipment for handling ingots and ladles, installed in steel plants during the war period, has been Alliance.

LADLE CRANES . GANTRY CRANES . FORGING MANIPULATORS . SOAKING PIT CRANES STRIPPER CRANES . SLAB AND BILLET CHARGING MACHINES OPEN HEARTH CHARGING MACHINES.

Alliance

THE ALLIANCE MACHINE CO., ALLIANCE, OHIO - SPECIAL AND STANDARD CRANES FOR HEAVY DUTY

NEW *Push Button* CONTROL

for D-C FLOOR OPERATED CRANES

Compact—Easy to mount—Easy to wire
Provides Accurate Speed Regulation

THIS EC&M standardized line of controllers is designed for (1) accurate inching, (2) compact mounting, and (3) minimum collector-bar requirements. They can be conveniently installed along the crane girders or mounted on the trolley, as required.

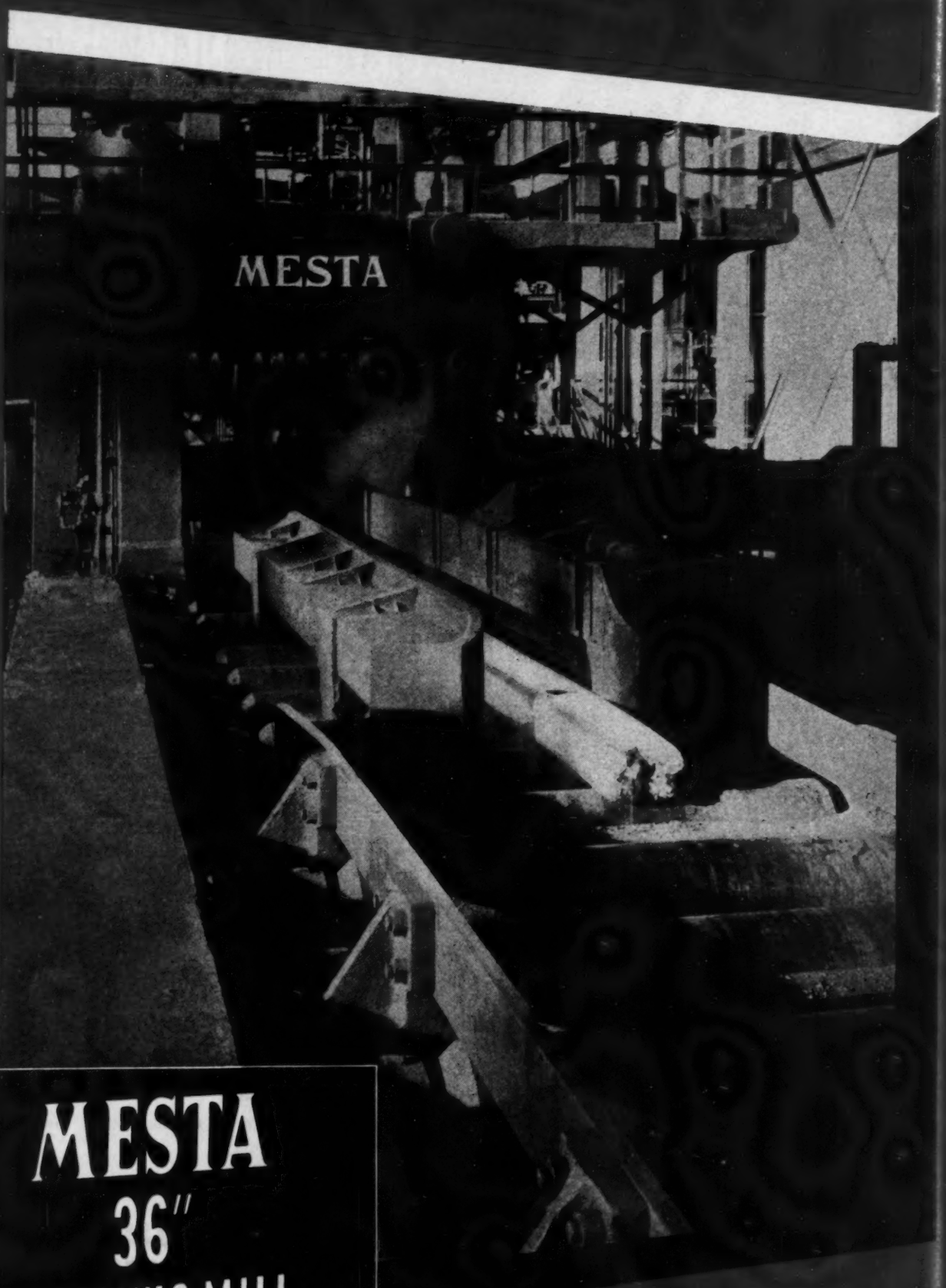
They have all the advantages of the well-known EC&M Control for *cab-operated* cranes. Acceleration is by the TIME-CURRENT method. Contactors are of the heavy-duty, magnetic type. Resistors are carefully proportioned for low-torque hoisting of light loads and for smooth acceleration of bridge or trolley. All motions can be controlled from a single, pendant, master-station complete with Pilot Light, Reset Button, and Emergency Stop, Double Pole control-circuit, Toggle Switch with two Push Buttons for each motion. Individual rope-operated Master Switches for the various motions are optional.

Bulletin 922 gives complete data, description, dimensions, etc. Send for your copy today.

THE ELECTRIC CONTROLLER AND MANUFACTURING CO.

2698 East 79th Street **Cleveland 4, Ohio**

Designed and built by **MESTA**



MESTA
36″
BLOOMING MILL

ARMY E NAVY

for KAISER *Company Inc.*

IRON AND STEEL DIVISION, FONTANA, CALIF.

MESTA 29" STRUCTURAL MILL

MESTA MACHINE COMPANY

PITTSBURGH, PA.
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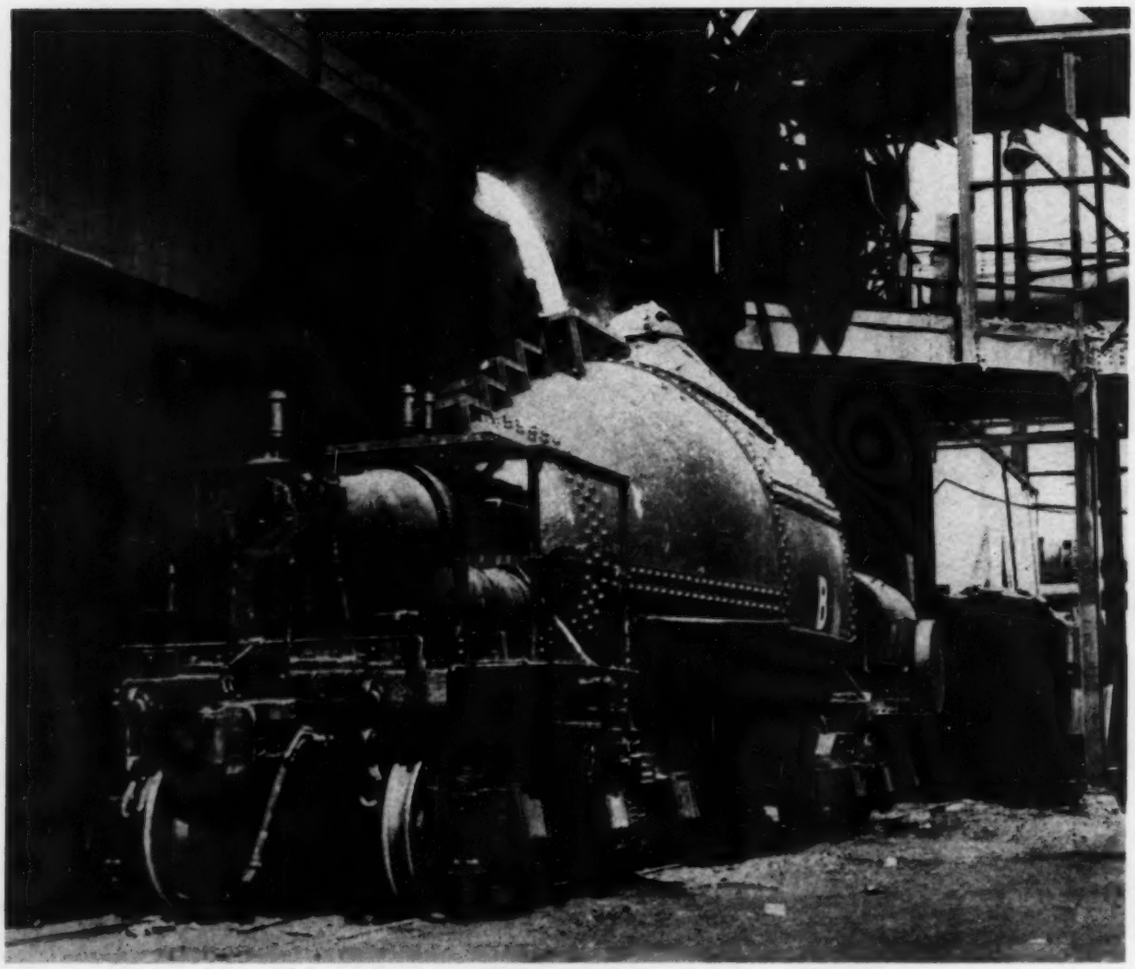
TREADWELL

MODERN LARGE CAPACITY BLAST FURNACES
SELECT
MIXER TYPE HOT METAL CARS



TO REDUCE

INCLUSIONS — MOTIVE POWER COSTS — SKULLING
CAST HOUSE LABOR — HEAT LOSSES — RUNNER SCRAP
LINING COSTS — LABORATORY ANALYSES — MAINTENANCE

M. H. TREADWELL CO.

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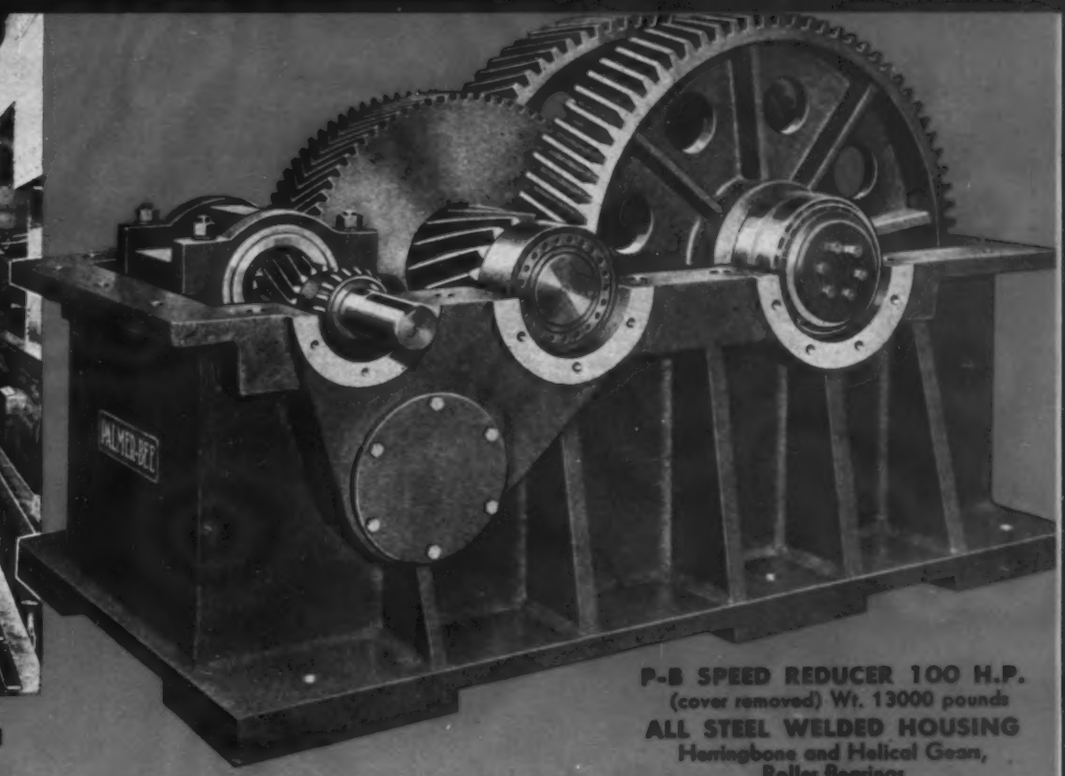
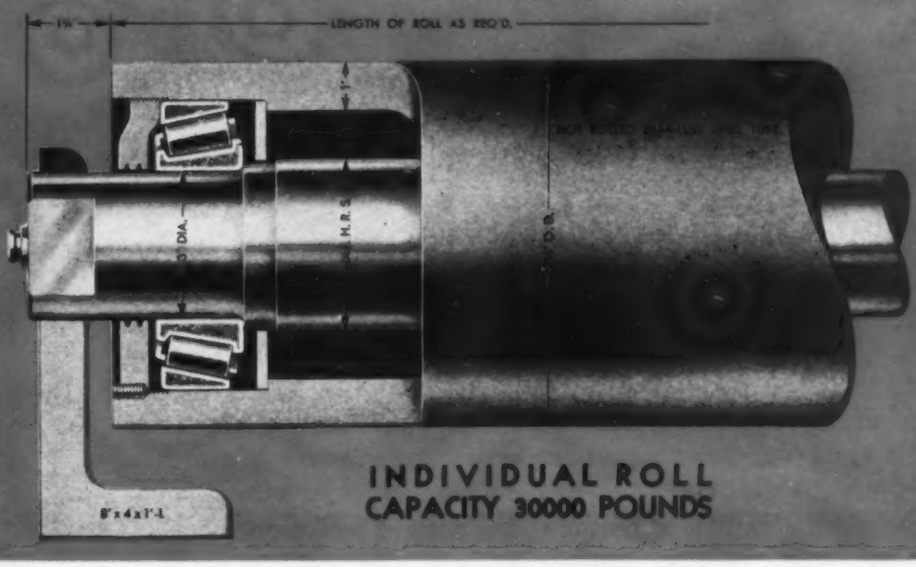
Upender receives red-hot coils and sets them on conveyor without shock.



P-B SPEED REDUCER 100 H.P.
(cover removed) Wt. 13000 pounds
ALL STEEL WELDED HOUSING
Herringbone and Helical Gears,
Roller Bearings

Rugged-Dependable



INDIVIDUAL ROLL
CAPACITY 30000 POUNDS

An exclusive
P-B feature
TIMKEN EQUIPPED
GRAVITY OR
POWER DRIVEN
ROLL
spring mounted to absorb impact.

STEEL MILL PRODUCTION CONVEYED . . . As Stacks and Packs of Steel Plate and Coils of Strip Steel became increasingly heavier, Palmer-Bee anticipated the need for conveyors designed to withstand DEAD LOAD and SHOCK LOAD and prevent damage to product or conveyor.

Refinements of design and material are a regular engineering and manufacturing routine made in advance of demand . . . Years of experience in successfully forecasting the needs of steel mill conveyor equipment gives authority to Palmer-Bee recommendations and product.

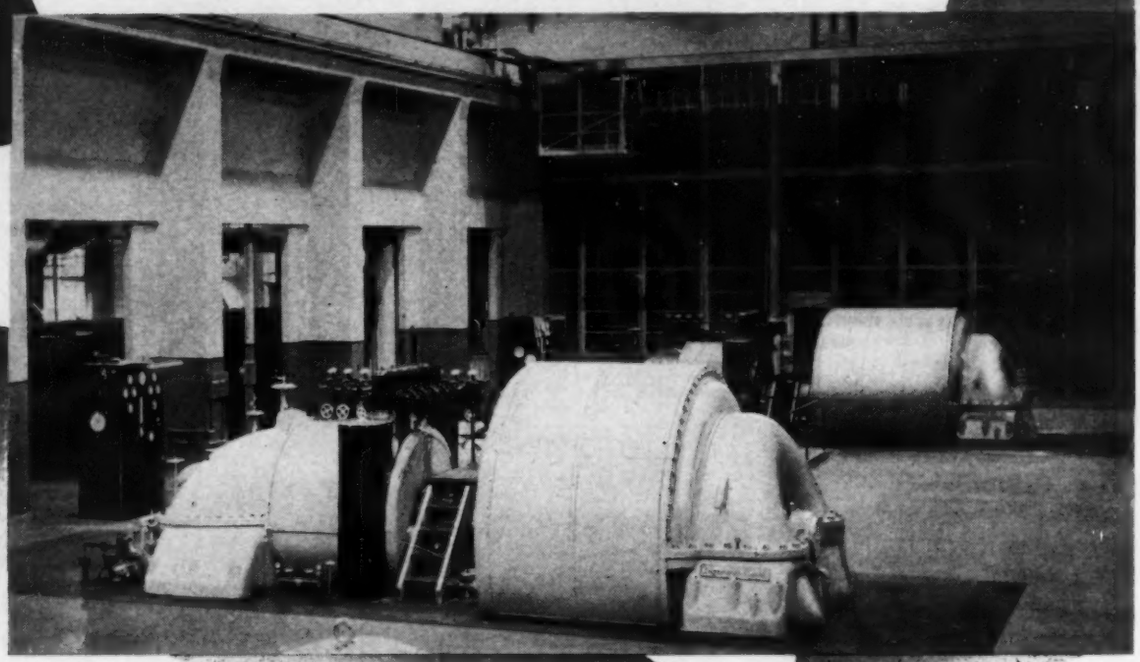
PALMER-BEE COMPANY

DETROIT 12, MICHIGAN

FACTORIES IN DETROIT, HAMTRAMCK, MICH., WINSTON-SALEM, N. C., BLOOMINGTON, IND

COMPLETE BLAST FURNACE BLOWER UNITS
by Ingersoll-Rand

TURBO BLOWERS
SURFACE CONDENSERS
AIR EJECTORS
CONDENSATE PUMPS



All of the blast furnace blowing equipment for the new Fontana, California, steel plant of The Kaiser Company has been supplied by Ingersoll-Rand. This dual installation includes 100,000-cfm steam turbine driven turbo blowers; two-pass surface condensers, vertically divided for cleaning; twin-element two-stage steam-jet air-ejectors; a pair of condensate pumps serving each condenser.

These units embody every refinement of design and a number of operating and control features which contribute to economical and efficient blast air supply.

The purchaser of a *complete Ingersoll-Rand blast furnace blower unit* enjoys the advantage of unified engineering and undivided responsibility... and avails himself of the wide experience gained during more than three decades of building turbo blower equipment. Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y.

12-655

COMPRESSORS • AIR TOOLS ROCK DRILLS • TURBO BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS • OIL AND GAS ENGINES

Why Fontana's water bill is low!

The FLUOR Cooling Towers at Fontana handle 72,306,400 gallons of water per day and a heat load of 383,950,000 B.T.U. per hour. Yet the water make-up required is less than 2% of total circulation.

This relatively small amount of water can easily be treated at small cost to provide for elimination of dirt, scale and rapid corrosion which reduce efficiency of cooling equipment and water lines.

Seven Fluor Cooling Towers supply the cooling water required for the Coking Plant, Open Hearth and Blast Furnaces, Rolling Mill, Plate Mill, Power Plant and auxiliary units.

The high economy and efficiency of these Fluor Cooling Towers at Fontana is typical of the performance of Fluor Cooling Towers in any steel mill service.

All designs for FLUOR Aerator Cooling Towers and FLUOR Counter Flow Induced Draft Cooling Towers are fully protected by U.S. Patents and Patents Pending.

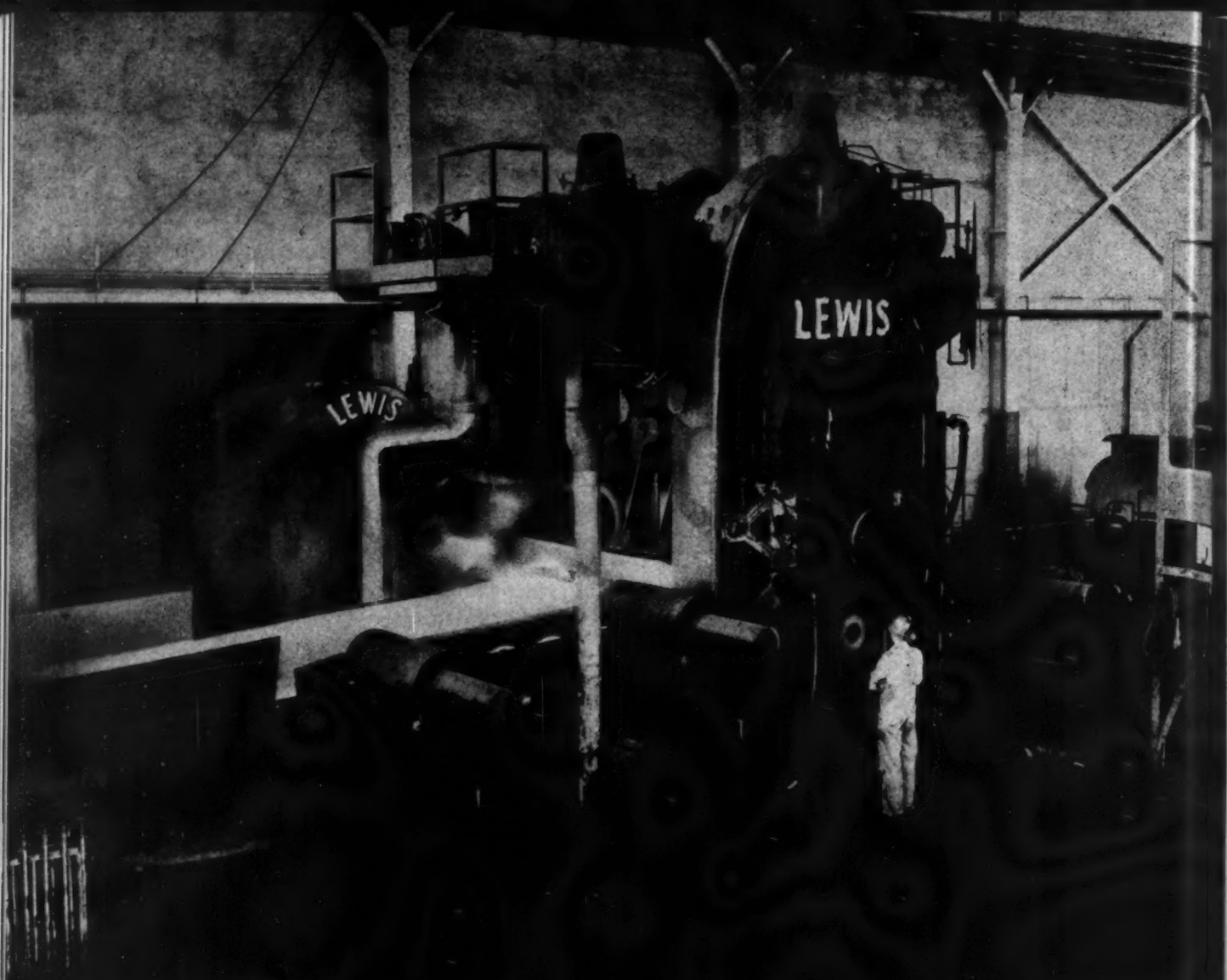
SINCE 1890

FLUOR

ENGINEERS • MANUFACTURERS • CONSTRUCTORS

PROCESS PLANTS AND EQUIPMENT FOR THE OIL, GAS AND ALLIED INDUSTRIES

THE FLUOR CORPORATION, LTD., 2500 S. ATLANTIC BLVD., LOS ANGELES 22 • New York, Pittsburgh, Kansas City, Houston, Tulsa



Birth of a Kaiser Ship

Production records of the Kaiser enterprises on the Pacific Coast have amazed industrial America . . . Pictured here is the Lewis 42 in. x 112 in. Three-High Finishing Mill, *part of the complete mill designed and erected by Lewis in the remarkable time of fourteen months*—engaged in turning out the vast tonnage of plate required for the great fleet of Kaiser-built ships.

ARMY NAVY

6 plants of Blaw-Knox Company have been awarded the Army-Navy "E" for excellence

MANUFACTURERS OF ROLLS AND ROLLING MILL MACHINERY FOR THE FERROUS AND NON-FERROUS INDUSTRIES

LEWIS

LEWIS FOUNDRY & MACHINE

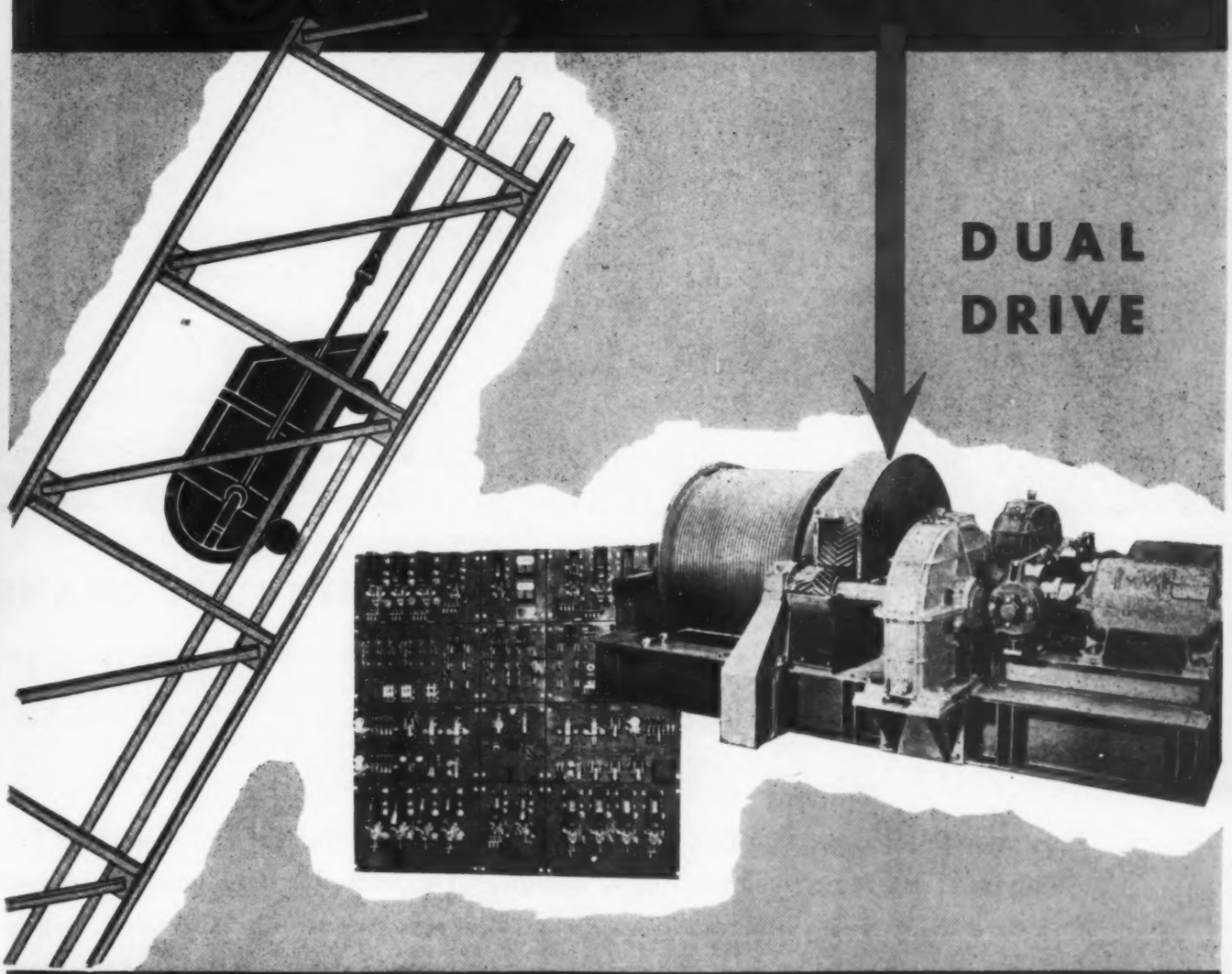
DIVISION OF BLAW-KNOX CO.

PITTSBURGH, PA.

FREYN DESIGN

SKIP HOISTS

—are establishing a superb record for Performance and Reliability



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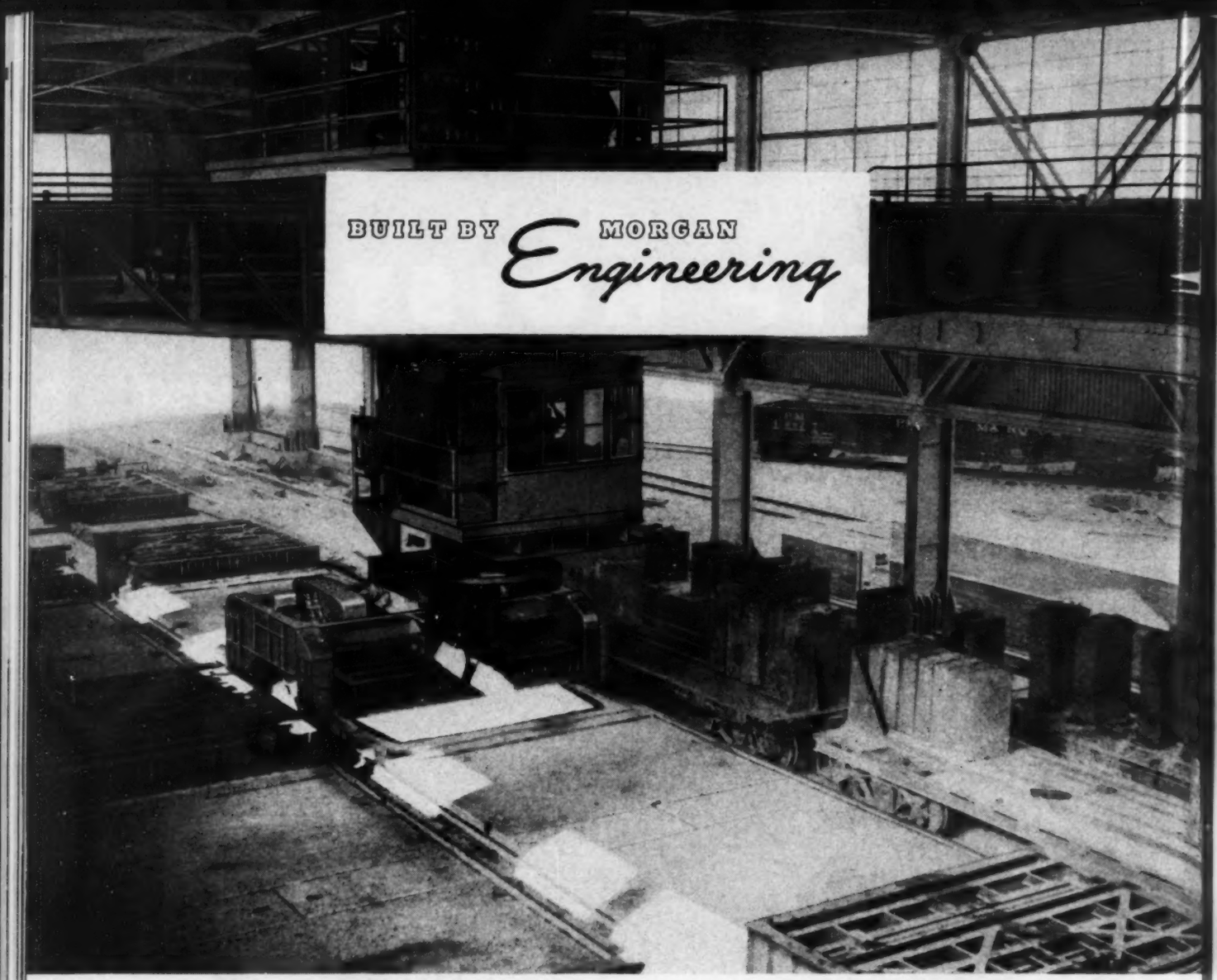
ASHMORE, BENSON, PEASE & CO. LTD., STOCKTON-ON-TEES, ENGLAND



MORGAN 10-TON SOAKING PIT CRANE

HANDLING SLAB INGOTS IN A WEST COAST STEEL PLANT

Illustrated is a Morgan 10-Ton, 7-Motor, 81′ 0″ Span Soaking Pit Crane with 15-Ton Auxiliary Hoist. Morgan superiority of design and construction is built into every part to insure many years of profitable service. It is equipped with fabricated welded trolley and bridge trucks and anti-friction bearings throughout. Trolley is of the worm operated type which simplifies the construction and lowers the cost of maintenance.

THE MORGAN ENGINEERING CO.

ALLIANCE, OHIO. 1420 Oliver Building, Pittsburgh

DESIGNERS • MANUFACTURERS • CONTRACTORS • BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS • ELECTRIC TRAVELING CRANES • CHARGING MACHINES • INGOT STRIPPING MACHINES • SOAKING PIT CRANES • ELECTRIC WELDED FABRICATION • LADLE CRANES • STEAM HAMMERS • STEAM HYDRAULIC FORGING PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

AT KAISER'S FONTANA MILL

The Blast Furnace Top

4 Ladle Cranes

2 Soaking Pit Cranes

2 Stripper Cranes

36" Blooming Mill

29" Structural Mill

Shears, Levelers, Gauges and Transfers

Equipped with

TRABON LUBRICATION

SERVICE-PROVED for years on revolving blast furnace tops, overhead cranes, mill stands, tables, and other steel mill equipment of all kinds, Trabon Lubrication makes absolutely certain that every bearing receives just the desired amount of lubricant while the mill is in operation. Individually engineered to your own particular requirements, Trabon Lubrication prolongs bearing life,— avoids breakdowns and production tie-ups,— minimizes accidents and compensation costs,— assures long, efficient, trouble-free operation.

Let Trabon engineers with their long, practical successful experience in steel mill work help you with your next lubricating job.

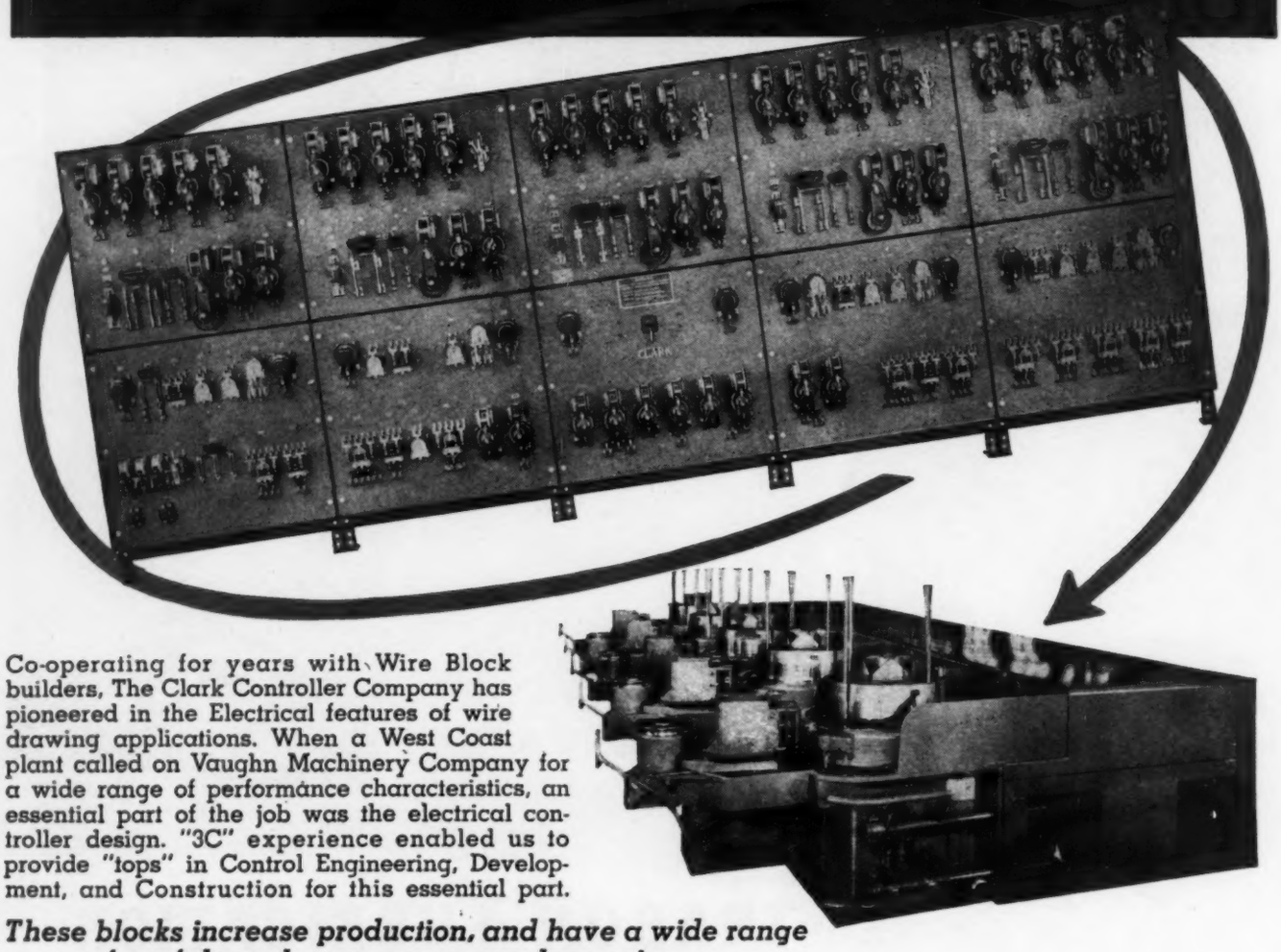
TRABON
ENGINEERING CORPORATION

1825 East 40th Street, Cleveland 3, Ohio • Industrial Lubrication Exclusively Since 1922

ORIGINATORS AND PATENT OWNERS OF THE SINGLE LINE REVERSING LUBRICATING SYSTEM

FEATURES THAT INCREASE WIRE DRAWING PRODUCTION—

Clark Control on a Vaughn (HRX) Motoblox



Co-operating for years with Wire Block builders, The Clark Controller Company has pioneered in the Electrical features of wire drawing applications. When a West Coast plant called on Vaughn Machinery Company for a wide range of performance characteristics, an essential part of the job was the electrical controller design. "3C" experience enabled us to provide "tops" in Control Engineering, Development, and Construction for this essential part.

These blocks increase production, and have a wide range of usefulness because you can draw wire on:

1. **Any 1 or more, or all 5 blocks at once separately**
2. **All 5 Blocks Continuously**
3. **1 Single Block and 4 Continuously**
4. **2 Blocks and 3 Continuously**

These blocks are simple to string up because you can:

5. **Inch separately or in groups**
6. **Reverse each Block separately or in groups**

"3C" Bulletin 7400 D.C. Contactors provide forward and reversing motions for the five 75 HP., 230 V., D.C. motors driving the Blocks. The Operator chooses the six single or multiple operations with the Selector Switch shown in the center panel.

Twenty-five "3C" Vari-Time Accelerating Contactors provide accurate trouble free acceleration, and save space because their timing is inherent; thus 25 separate accelerating relays are unnecessary.

The same Vari-Time reliability is incorporated in the relays for sequence operation.

The same "3C" Heavy Duty Mill Type Control that renders low maintenance service throughout industry adds another feature: RELIABILITY.

This Vaughn Motoblox Wire Drawing Machine is versatile. It draws 1" maximum low carbon wire (single hole) and ⅝" maximum high carbon wire.

Six operational combinations (as shown in the data on control) are possible.

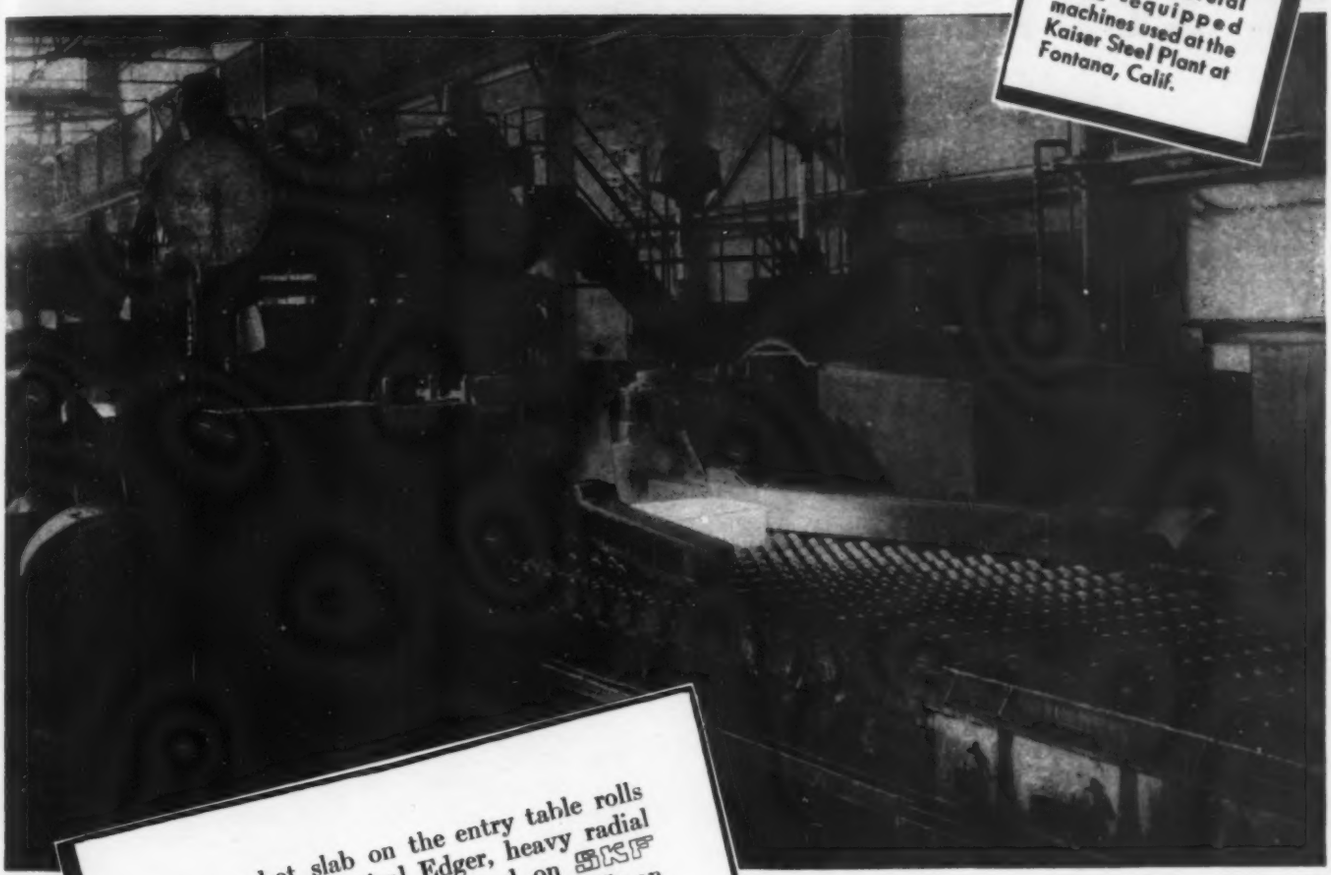
●

THE CLARK CONTROLLER CO.

1146 EAST 152nd ST., CLEVELAND 10, OHIO • CONTINUE TO ROLL WITH CLARK CONTROL

ON THE 44" VERTICAL EDGER AT FONTANA

Built by LEWIS FOUNDRY & MACHINE, this 44" Vertical Edger is one of several SKF-equipped machines used at the Kaiser Steel Plant at Fontana, Calif.



When a hot slab on the entry table rolls into this 44" Vertical Edger, heavy radial and thrust loads are imposed on SKF Spherical Roller Bearings. But SKF's on vertical rolls and drive shafts take them easily, and steel men who have used SKF Bearings know why. Because built-in alignment enables SKF's to compensate for shaft deflections, distortions or weave without binding. Because the resultant high capacity is always available for useful work. In exchange for only occasional lubrication, SKF's give a long life of trouble-free performance.

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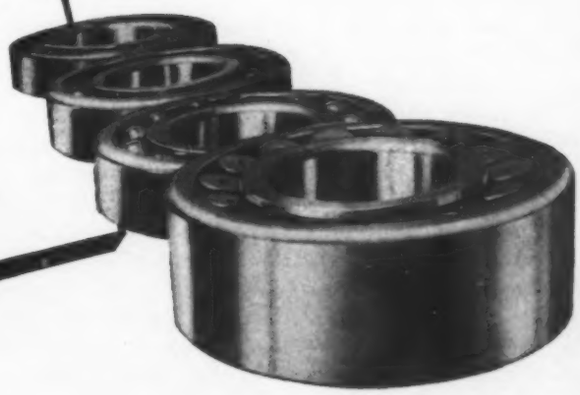
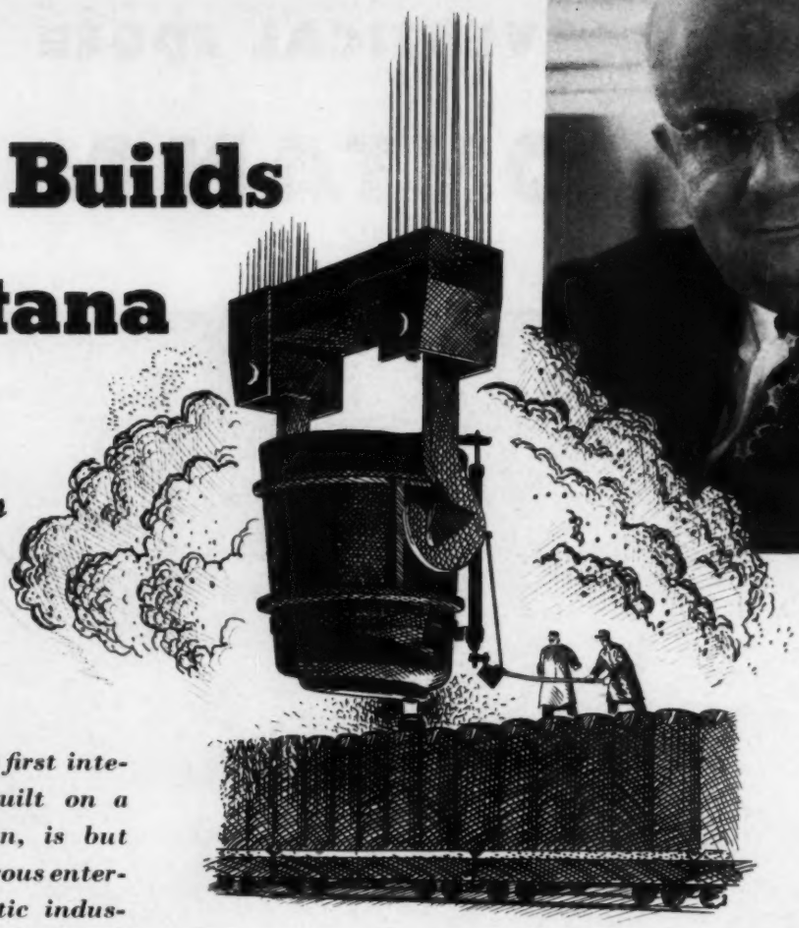


Kaiser Builds at Fontana



by T. J. Ess

. . . . the West Coast's first integrated steel plant built on a $115,000,000 RFC loan, is but one unit in the numerous enterprises of that energetic industrialist, Henry J. Kaiser, whose empire now embraces steel, shipbuilding, cement, machinery and light metals . . .

▲ NEAR Fontana, California, about 65 miles from Los Angeles harbor, lies the steel plant of Kaiser Company, Incorporated, one of the major units in the diversified Kaiser activities, and one of the important units in the expansion of the nation's steel producing capacity. Built to turn out steel plate quickly and in quantity, this plant exceeded its rated capacity for this product within 20 months first breaking ground.

Indeed, one of the outstanding things about the plant is the speed of construction, as indicated by the following schedule:

Site purchased	March, 1942
Blast furnace blown in	December, 1942
Open hearth tapped	May, 1943
Plate mill started	August, 1943
36 in. mill started	June, 1944
29 in. mill started	August, 1944
Merchant mill started	February, 1945

This was accomplished by wholesale cutting of red tape and by a remarkable expediting system.

The plant was built on a 1300 acre site which allows plenty of room for expansion. The location was to some extent dictated by circumstances of security prevailing at the time construction was started, which would not allow putting the plant on tidewater. The ground is firm and practically level, so that no piles were necessary to support the heavy equipment. All foundations were placed on spread footings. Special precautions were taken in the design of stacks, coal bins, quenching station and other structures to enable them to resist earthquake movements. All of the mill buildings are of flat roof design in 25 ft bays, one low bay alternating with three high bays.

Being located in the midst of an agricultural district (in fact, about half of the plant property is still under cultivation), the plant contains practically every device to prevent contamination of the surrounding territory by fumes, smoke and other waste. Another problem presented by the location is that of water supply. There being no adjacent streams, all water is purchased and for this reason, as well as because of the waste disposal problem, water is conserved by recirculation to a degree very unusual in steel plants.

Occupying a plot approximately 6000 ft x 4500 ft, the plant presents a spacious layout designed to reduce material handling, cross-hauling and back-tracking to a minimum. Contributing materially to this is the extensive use of belt conveyors, of which approximately 14,000 ft are installed. Main rail lines of the Santa Fe and the Southern Pacific railroads, and a short connection to the Union Pacific, provide excellent transportation facilities.

RAW MATERIALS

Coal comes principally from the Sunnyside seams in the Mesa Verde formation, located in Carbon County, Utah, approximately 800 miles from Fontana. These seams, ranging 5½-9½ ft deep, are worked in room-

and-pillar fashion, undercutting and blasting. The coal is then loaded mechanically, gathered from the entries to the slope, rope-hauled up the slope to a motor road and finally transported by motor haulage to the surface tipple.

At the tipple, the run-of-mine is first crushed to −8 in. in a double roll crusher and passed over a 3 in. raw coal screen. The 8 x 3 in. then passes over the picking table, while the −3 in. coal is washed in a jig and then blended with the larger hand-picked coal for shipment. Coal under 3/16 in. is dewatered in a centrifugal dryer, as is thickener sludge from the washer. Washer loss amounts to about 3.5 per cent of the raw coal, but results in a reduction of ash and sulphur as indicated in the following averages:

	Per cent	
	Raw	Cleaned
Moisture	5.8	6.1
Volatile	38.5	38.6
Fixed carbon	48.2	49.1
Ash	7.5	6.2
Sulphur	1.28	1.06

There are an estimated 15,000,000 tons of coal in the present lease in the Book Cliffs field which represents a coal supply of 22 years at the present normal consumption.

A low volatile coal of the Pocahontas type is also obtained from the Oklahoma fields, a rail haul of about 1400 miles. This coal analyzes somewhat as follows:

	Per cent
Moisture	3.6
Volatile	17.9
Fixed carbon	70.9
Ash	11.2
Sulphur	1.13

Normal practice calls for a mixture of 12½ per cent of the low volatile Oklahoma coal and 87½ per cent Sunnyside coal.

As received at Fontana, coal is unloaded from the hopper cars into a track hopper and taken by conveyors either to the storage pile or to the coal handling system at the coke plant. A coal storage of 10,000-20,000 tons is maintained at the steel plant. However, since Sunnyside coal deteriorates rapidly in storage, about one-half

From the Sunnyside seams in Utah comes high volatile coking coal which, after crushing and cleansing, is shipped 800 miles ← to the steel plant.

At Vulcan mine, 175 miles from Fontana, iron ore is loaded by diesel shovels into trucks which carry it to a primary crusher from where it is trucked to a rail spur 9 miles away. →

of each day's requirement is taken from the oldest part of the storage pile and replaced by new coal, so that no coal is in storage more than about 20 days. The coal handling equipment has a capacity of 250 tons per hr.

Ore comes to Fontana from the company owned Vulcan mine, located near Kelso in San Bernardino County, 175 miles from the steel plant and from mines west of Cedar City, Iron County, Utah, about 500 miles from the plant. The Vulcan ore is a relatively hard mixture of hematite and magnetite with a small amount of pyrites, and is almost self-fluxing. The deposit, which is about 500 ft deep with little overburden in places, has been estimated at more than 5,000,000 tons, of which about half can be obtained by economical open pit operations. The ore shows analyses ranging as follows:

	Per cent
Fe	51-55
P	.03
Mn	.10
SiO_2	4.95-5.95
Al_2O_3	.61- .95
CaO	4.03-6.27
MgO	3.32-3.61
S	.21- .49

The ore body is drilled about 40 ft deep with rotary and churn drills. After shooting, the ore is loaded into 10 cu yd trucks on different levels by 2½ cu yd diesel shovels, and hauled to a primary crusher bin. From the bin, ore passes over an 8 in. screen with the oversize material then being crushed to −12 in. Motor trucks then convey the ore in 25 ton loads to the railroad spur 9 miles away. The trucks dump into a receiving bin and the ore is then loaded into 70 ton hopper cars by a weighing conveyor belt.

Recently, 35-40 per cent of the ore requirements have been brought in from deposits near Cedar City, Iron County, in southwestern Utah. This involves a rail haul of almost 500 miles, but the move was deemed advisable in order to lower the sulphur content of the blast furnace charge. The Utah ore has an analysis averaging as follows:

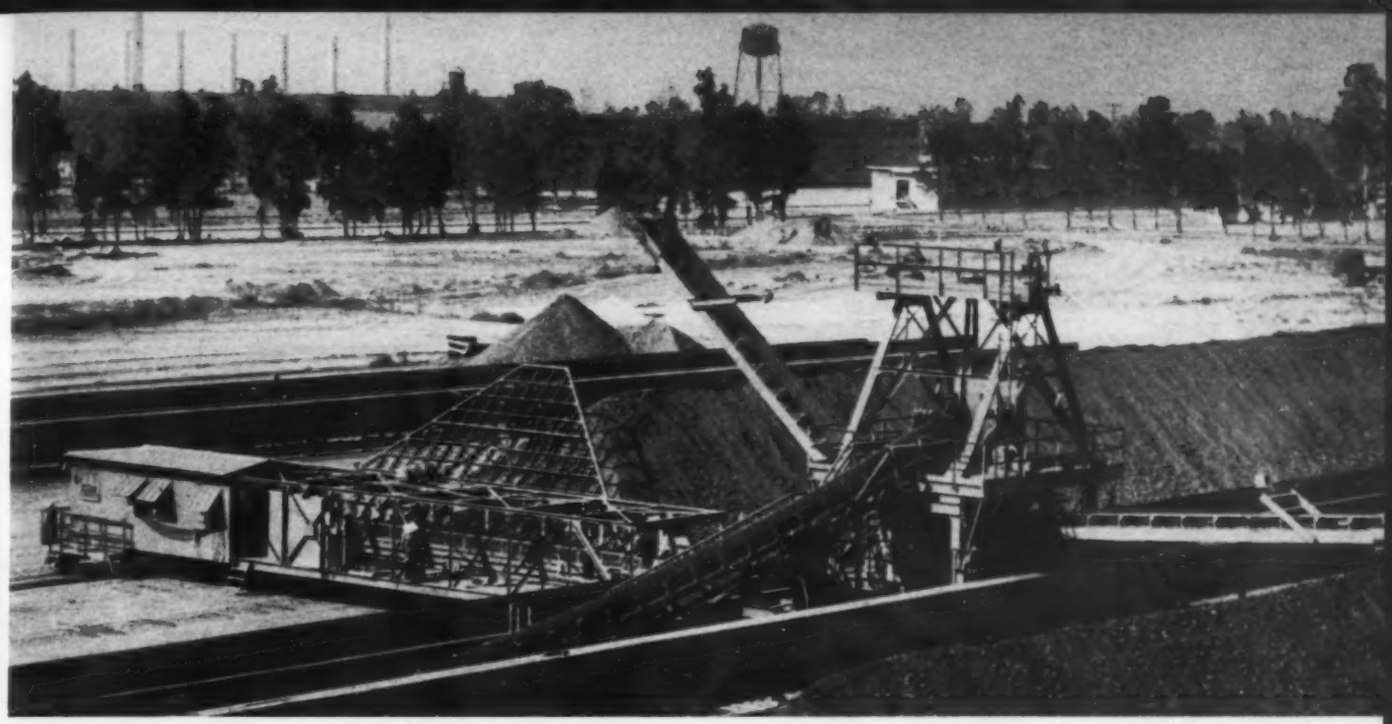
	Per cent
Fe	56.79
P	.202
Mn	.08
SiO_2	7.20
Al_2O_3	1.82
CaO	1.33
MgO	2.13
S	.096

Another ore mine at Eagle Mountain in Riverside County, California, has been purchased. This is a fairly large deposit (proved for 21,600,000 tons) with minimum overlay extending for about 6½ miles in a mountain range. This deposit is only 153 miles from the steel plant. This ore is said to analyze 51 per cent iron and through benefication can be brought to 60 per cent.

There are many additional small deposits of iron ore within a radius of 150 miles of Fontana, as well as other deposits on the west coast of Mexico.

Arriving at the plant, ore is unloaded into two hoppers by a rotary car dumper and conveyed to the crusher building, where it is crushed in a primary jaw crusher set to 5 in., and passed over a 3½ in. screen. The oversize is again crushed in two cone crushers to

General view of the raw material area, showing sintering plant at left, with storage piles, crushing and screening station and rotary car dumper at right. Extensive use of belt conveyors may be noted.



Raw materials are stored in a bedding system, being piled by traveling stockers as shown in the foreground and withdrawn by reclaimers as shown at left.

−3 in., which joins the undersize from the screen, and is then normally conveyed to a storage yard. Here the ore is bedded in four 15,000 ton piles so as to average out variations in analysis. Two traveling stackers operate between the rows.

The ore reclaimer, through an inclined oscillating rake attachment, takes off an accurate cross-section of the pile. By means of a transfer car running across the ends of the four ore piles, the reclaimer can be moved from pile to pile, from which it can feed one of three conveyor belts leading to a screening station. This station has a two-deck screen and is eventually to be used for ore classification. At present, however, screening is done only to remove −¼ in. material, which amounts to 35-40 per cent of the total and is taken to the sintering plant.

This ore handling system has a capacity of about 300 tons per hr, so that the daily requirement may be handled in a single 8 hr shift.

Limestone, sized 5 x 1½ in., is purchased from an outside quarry only 12½ miles from the plant. It is a crystalline material and seems to be just as adaptable as the amorphous type. Received in railroad cars, the stone is unloaded into a track hopper and handled by belt conveyors either to a crusher, stockpile and vibrating screen, or to the blast furnace bins.

Manganese ore is stocked in three grades (15-30 per cent, 30-40 per cent and over 40 per cent) and is obtained principally from Lower California, Mexico. The use of open hearth slag in the blast furnace burden has materially reduced the requirements for this ore.

An alumina clay is used in the blast furnace to increase the alumina in the slag. This material comes by truck from company owned pits at Corona, 30 miles from the plant.

Dolomite comes from quarries in northern California but it is planned to open a nearer source.

Fluorspar is purchased from mines in Nevada and Arizona.

COKE PLANT

Coke ovens are arranged in two batteries, each of 45 underjet combination ovens of low differential type, 13 in. and 15½ in. wide x 40 ft 5½ in. long inside of doors x 13 ft high, and located on 3 ft 7½ in. centers. Thus, each oven has a capacity of 576 cu ft based on a 12 in. coal line, or, with a bulk density of 50 lb per cu ft, 14.4 tons of coal. The oven walls are of hammerhead rectangular construction with 28 vertical flues on 17⅝ in. centers, built with 6 in. bottle brick. Liners are 5½ in. wide for the first two courses, 5 in. wide for the next two courses and 4 in. wide for the remaining courses to the collecting flue. All vertical flues except the end flues unite in groups of four into the collecting flues. Eight cross-over flues are provided, one from each collecting flue and one from each pair of end flues to the corresponding flue on the other side of the oven. Each oven chamber has three 14 in. charging holes in the top, and two gas off-takes of 14 in. diameter.

The ovens are regenerative, designed for operation with either coke oven gas or blast furnace gas, and are arranged for automatic recirculation of hot waste gas when using coke oven gas, so as to improve uniformity of vertical flue temperature. A concrete stack 225 ft high serves each battery of ovens.

The coke side bench is supported independently of the oven buckstay construction in order to eliminate transmission of vibration from machinery to the battery. Alley enclosures below the oven benches are of open construction as usual in the mild climates.

Oven machinery includes one pusher, one charging larry, two traveling coke guides, two quenching cars and one quenching locomotive.

Two batteries, each of 45 coke ovens, are placed end to end, giving a total coking capacity of 1728 tons of coal per day.

Coal handling equipment includes a breaker, hammer mill, four 150 ton mixing bins and an 1800 ton oven storage bin, with the necessary connecting conveyors. Coal coming to the plant is, as previously mentioned, a mixture of new coal and coal from stock. This mixture is conveyed to the breaker, where it is crushed to approximately 1½ in. in size and some boney, slaty material is removed. Belt conveyors then carry the coal to the four mixing bins, where coal blending may be effected. Next, the coal is carried to the hammer mill where it is reduced in size so that 50 per cent or more will pass through a ⅛ in. screen. Finally, conveyors take the coal to the 1800 ton storage bin, located at the end of the oven batteries and arranged in three sections, with six discharge gates at the bottom of each section. When the three-hopper charging larry receives its 14.4 ton oven charge, the discharge gates on the storage bin are automatically closed. Coal handling equipment has a capacity of about 250 tons per hr, so that the daily coal consumption may be handled in an 8 hr turn.

In the original arrangement, coke was transported by belt conveyor from the coke wharf to the screening station, where it was passed over a double-deck screen which separated it into the three sizes: furnace, nut and breeze. Furnace coke was then transported to the blast furnace bins by a belt conveyor, a rather unusual feature in this application. The coke was again screened at the top of the furnace bins, chuted into the bins, and again rescreened when it was drawn out into the skip cars. This practice was found to give considerable breakage, and produce a small furnace coke and excessive amounts of nut and breeze.

Accordingly, the coke handling setup has been revamped, with a 1200 coke storage bin installed between the ovens and the blast furnace. Coke direct from the wharf is unloaded into this bin by a tripper belt and is drawn from the bottom of the bin through gates on to belts which serve as feeders directly to the skip screens. Thus, the first and only screening through which the coke passes is just ahead of the skip cars. The small coke rejected in this screening is returned to a new screening station and graded into small sizes, at present consisting of ½ x 1 in. nut coke and −½ in. breeze.

A complete by-product and benzol plant is provided, including equipment for the dephenolization of the still waste liquor and for processing by-products farther than is usual in steel plants. Equipment installed here includes the following items:

Direct primary gas coolers with auxiliary pipe cooling coils. The water from these coolers circulates through an atmospheric cooling tower which also serves the blast furnace gas washer.

Flushing liquor decanter tanks with scraper conveyors for removal of pitch.

Electrical precipitators for cleaning the gas.

Two saturators (one operating and one spare) for removal of ammonia from the gas, each with a mechanical agitator to increase sulphate crystal size.

Final cooler with tar absorbing section in the base of the cooler to remove naphthalene from the recirculated water. An atmospheric cooling tower is installed in this recirculating system.

Benzol scrubbers with spiral metal packing for the removal of light oil.

Complete light oil and benzol plant, including wash oil still, wash oil rectifier and oil purifier.

Light oil refining equipment including continuous carbon disulphide and motor fuel column, and batch pure still and crude column.

A coal tar distillation plant which produces creosote and pitch.

Most of the ground in the by-product area has been hard-surfaced with a bitumastic material in order to overcome a dust nuisance which is caused by high winds. This paving also permits these areas to be easily drained and cleaned.

Based on an 18 hr coking time, the total carbonizing capacity of the two batteries of ovens is 1728 tons of coal per day, producing 1060 tons of furnace coke (61.25 per cent yield) and 116 tons of breeze and nut coke. Total coke yield averages about 67.9 per cent. By-product yields per ton of coal, under normal operation with 87½ per cent Sunnyside coal and 12½ per cent Oklahoma coal, average about as follows:

Coke oven gas	11,318 cu ft
Tar	10.32 gal.
Ammonium sulphate	27 lb
Light oil	3.69 gal

Fractionating the light oil gives approximately 2.5 gal of benzol, .68 gal of toluol and .48 gal of xylol, naphtha, etc., per ton of coal. Distillation of the tar results in 6 gal of creosote oil, 1.2 gal of residue fuel and 55 lb of pitch per ton of coal.

All of these yields are corrected to a moisture content of 3 per cent in the coal and coke.

Coke oven gas (averaging 555 Btu gross, 494 Btu net, per cu ft) is used principally in the open hearth furnaces, soaking pits and heating furnaces, with some going to boilers, coke ovens, blast furnace, etc. A 500,000 cu ft holder in the coke gas system helps to maintain a balance between gas production and consumption. Blast furnace gas is generally used for underfiring the coke ovens.

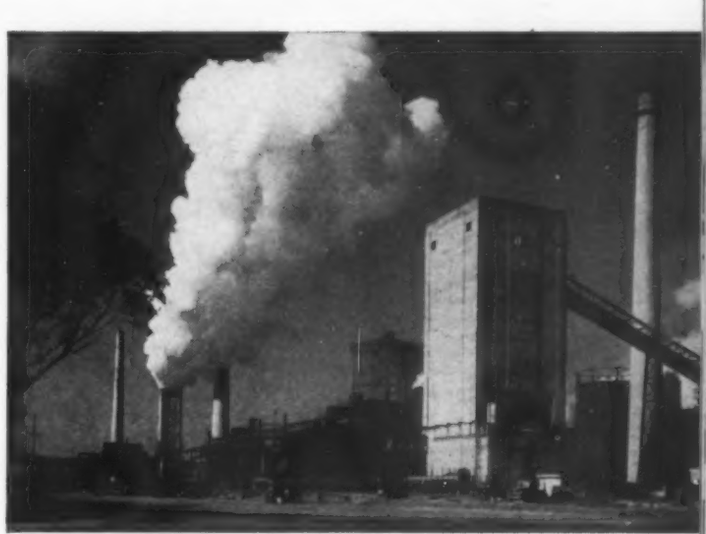
No mixed gas system is installed at present but one is contemplated for the near future. At present, coke oven gas, as well as blast furnace gas, is distributed separately under the supervision of a gas dispatcher.

Coke from the mildly coking Sunnyside coal is porous and free-burning but is fingery and relatively weak, and breaks easily. It is for this reason that the coke handling arrangement has been changed as previously mentioned.

It has been found that the best coking practice for this coal calls for an initial oven temperature of about 2100 F when charging. To attain this temperature without damaging oven walls requires a slow coking time. A low flue temperature (approximately 2350 F) is usually carried and the ovens are "gassed out" after 14 hr. During the remaining 4 hr of the normal coking time, the oven temperature then rises to 2100 F, when the oven is pushed, leaving the temperature high enough for the next charge.

A program of experimentation, with the view of improving the coke, has proceeded almost continuously since the start of operations. The addition of ½-1 pint of oil per ton of coal, mixed in just ahead of pulverization in the hammer mill, has been found to increase bulk density of the charge about 6 per cent, increasing production and improving coke strength somewhat. This is particularly advantageous during the rainy season, when moisture tends to become excessively high. Also, the use of 2-3 per cent of flake pitch from the tar distillation plant, added to the coal ahead of the breaker, has been found to give better physical structure of the coke, with higher screen, shatter and tumbler values.

More recently, the mixing of low temperature precharred coal with the regular high volatile coal has been found very beneficial, and the installation of a low



At one end of the coke oven batteries is the coal storage bin; at the other end is the quenching station. Both of these structures are of reinforced concrete construction.

▲

View of by-products area showing, left to right, ammonium sulphate building, saturator tank, exhauster and booster building, and ammonia liquor cooling coils.

temperature char pilot plant is under way. Meanwhile, a remarkable improvement in coke quality, with a corresponding improvement in blast furnace practice, has been effected by the use of about 12½ per cent of the low volatile coal, similar to Pocahontas, from the Oklahoma fields.

BLAST FURNACE

The blast furnace is designed in accordance with modern practice for a capacity of 1200 tons of pig iron per day. The hearth diameter is 25 ft 6 in., the bosh diameter 28 ft 3 in., and the stockline diameter 19 ft 6 in. The diameter of the large bell is 14 ft 5 in., leaving an annular space around the bell of 2 ft 6½ in.

The height of the furnace is 97 ft 6 in. from iron notch to deck ring, somewhat less than usual in recent eastern furnaces because of the relative weakness of the coke. The iron notch is placed 2 ft 3 in. above the furnace bottom and the cinder notch is 4 ft 8 in. above the iron notch. Sixteen tuyeres are spaced around the furnace 3 ft 4 in. above the cinder notch.

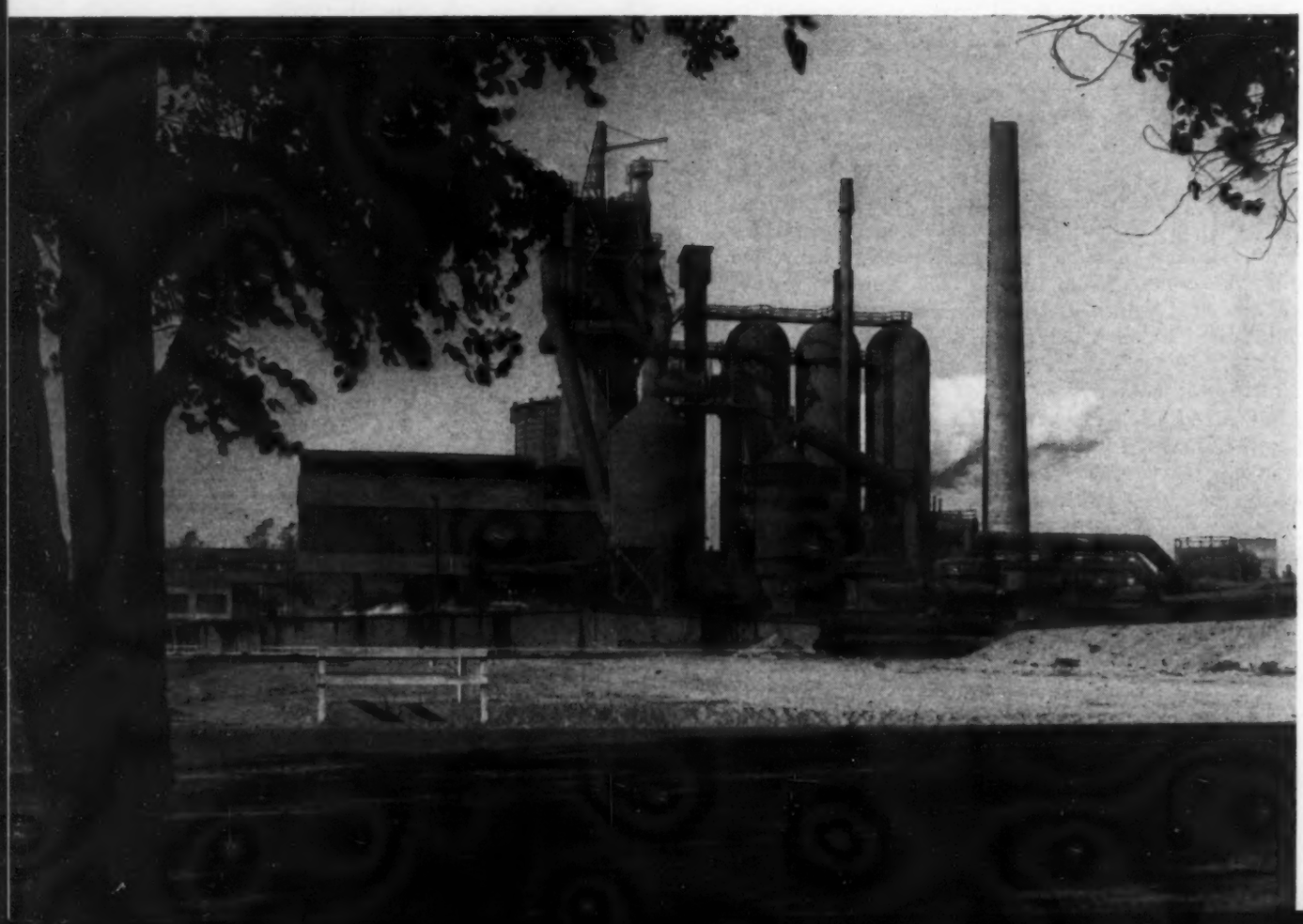
The bosh angle is 83 degrees, 19 minutes, the sloping section being 11 ft 9 in. high and topped by a straight section 7 ft 6 in. high. The inwall section has a slope of .9722 in. in 12 in. and is 54 ft high. The stockline section is 14 ft high.

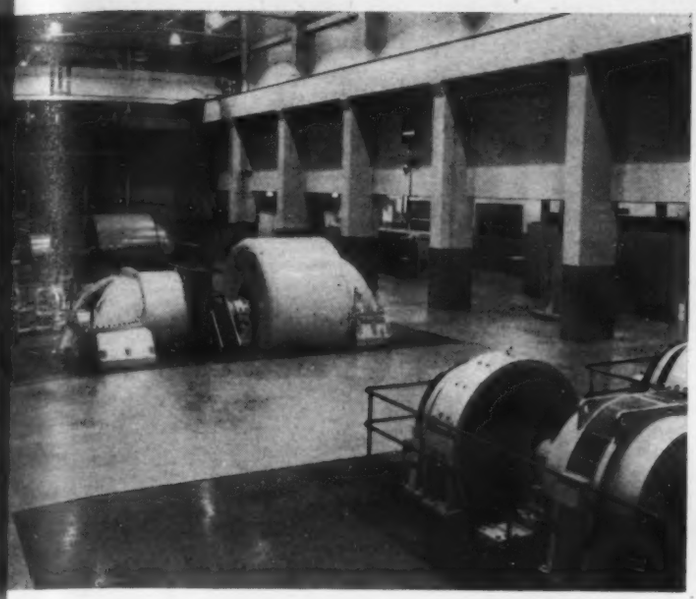
The furnace is charged by a conventional double skip with cars of 200 cu ft capacity (each car holding 4800 lb of coke or 13,600 lb of ore) dumping into a rotating distributor top. A charging sequence of ore, coke, stone, ore, coke is normally used for straight filling. The average burden consists of:

	Lb per charge
Utah ore	14,500
Vulcan ore	7,000
Manganese ore	800
Sinter	18,400
Open hearth slag	3,000
Coke	18,000
Clay (for flux)	2,000
Limestone	5,800

Blast volume averages about 65,000 cfm and is supplied from either of two turboblowers, each rated at 100,000 cfm. These units are not duplicates, however. One unit has a 4-stage air end rated at 30 psi maximum pressure and is driven by an 11,500 hp turbine. The other unit has 5 stages, is rated at 35 psi maximum pressure and is driven by a 12,600 hp turbine. Surface condensers on these turbines contain, respectively, 10,000 and 10,450 sq ft of surface, both units being of 2-pass design and supplied with 12,300 gpm of circulating water. Under design conditions, an exhaust back pressure of 2 in. of mercury is maintained.

Designed for a capacity of 1200 tons per day, the blast furnace makes iron from a combination of materials never previously used for this purpose.





Interior of the power plant, with two turboblowers for the blast furnace. Motor-generator sets are shown in right foreground.

An unusual feature of this installation is the use of an electrostatic precipitator in the air intakes of the blowers. This was done to prevent cutting of the blower impellers by sand carried along by winds of 40 mph or more from the surrounding desert.

Blast to the furnace is heated in three side-combustion stoves 25 ft in diameter x 115 ft high, each containing 210,000 sq ft of heating surface. Pressure burners automatically proportion the blast furnace gas and air used to heat the stoves, and an automatic mixing valve controls blast temperature, which averages about 1000 F.

Gas leaving the furnace at temperatures averaging 400 F passes through a dust catcher, a wet-washer and two electrical precipitators, being finally cleaned to a content of .0085 grains of dust per cu ft. The gas is used in the stoves and boilers and under the coke ovens. A waterless type gas holder of 1,000,000 cu ft capacity offers some storage to bridge over short furnace delays.

Water from the wet-washer and the precipitator flows through a common duct to a 90 ft thickener. Sludge from the thickener can be pumped directly to a filtering unit in the sintering plant, and the resulting "cake" is fed, with fine ore, dry flue dust and coke breeze, to the pug mill and sintering machine.

Iron from the furnace flows into 150 ton ladles of the mixer type and is then taken to the open hearth department for use in the molten state or to a double-strand pig machine. This unit is 168 ft long and has a capacity of 1500-1600 tons per day. Pig weights of 40 or 90 lb may be used, with the former apparently giving better mold life.

Slag from the furnace (averaging about 1350 lb per ton of iron) flows into two open pits at the end of the cast house, where it is allowed to chill and is then loaded by an electric shovel into dump cars for disposal.

About one-third of the furnace charge is sintered at the present time. The sintering plant has a capacity of 1500 tons per day. Fine ore from the screening plant, flue dust from the blast furnace, mill scale from the rolling mills and coke dust are mixed and distributed on the traveling grate of the sintering machine, which is 72 in. wide x 110 ft long. This grate travels at an average speed of 43 in. per min with bed thicknesses of 6-12 in. The mixture is ignited by coke oven gas burners and 16 windboxes below the belt act to pull the fire down through the mixture. Suctions of 12-28 in. (15 in. average) may be maintained in these windboxes. Waste gases from the sintering machine are exhausted through a concrete stack 12 ft in diameter and 300 ft high. The sintered material is deposited on a rotary cooling wharf having a holding capacity of three hours production so that the sinter may cool without the use of water before being dumped on to the belt conveyor leading to the blast furnace bins. This gives a large heavy sinter which may also be used for open hearth feed ore. Some experimental work has been done on the effect of the size of coke in the sintering mixture. Coke breeze is now crushed in a rod mill to −10 mesh before being used in the sintering plant.

Space has been allowed for a second sintering machine should it be necessary to use more sinter in the blast furnace charge.

Faced with the problem of making iron from a combination of materials never previously used for this purpose, several operational problems were encountered, as might be expected. Coke was definitely on the small side because of excessive breakage, and a high copper loss was experienced. Changes in coke production and handling have improved this situation. The increased coke strength obtained through the use of some Oklahoma coal has resulted in greater iron production and lower tuyere loss. Production averages about 1155 tons per day, with a coke rate of 1570 lb per ton of iron. A daily record of 1446 tons has been established. The iron shows an analysis of:

	Per cent
Silicon	1.00 -1.25
Sulphur	.034- .050
Manganese	1.25 -1.50
Phosphorus	.275- .325

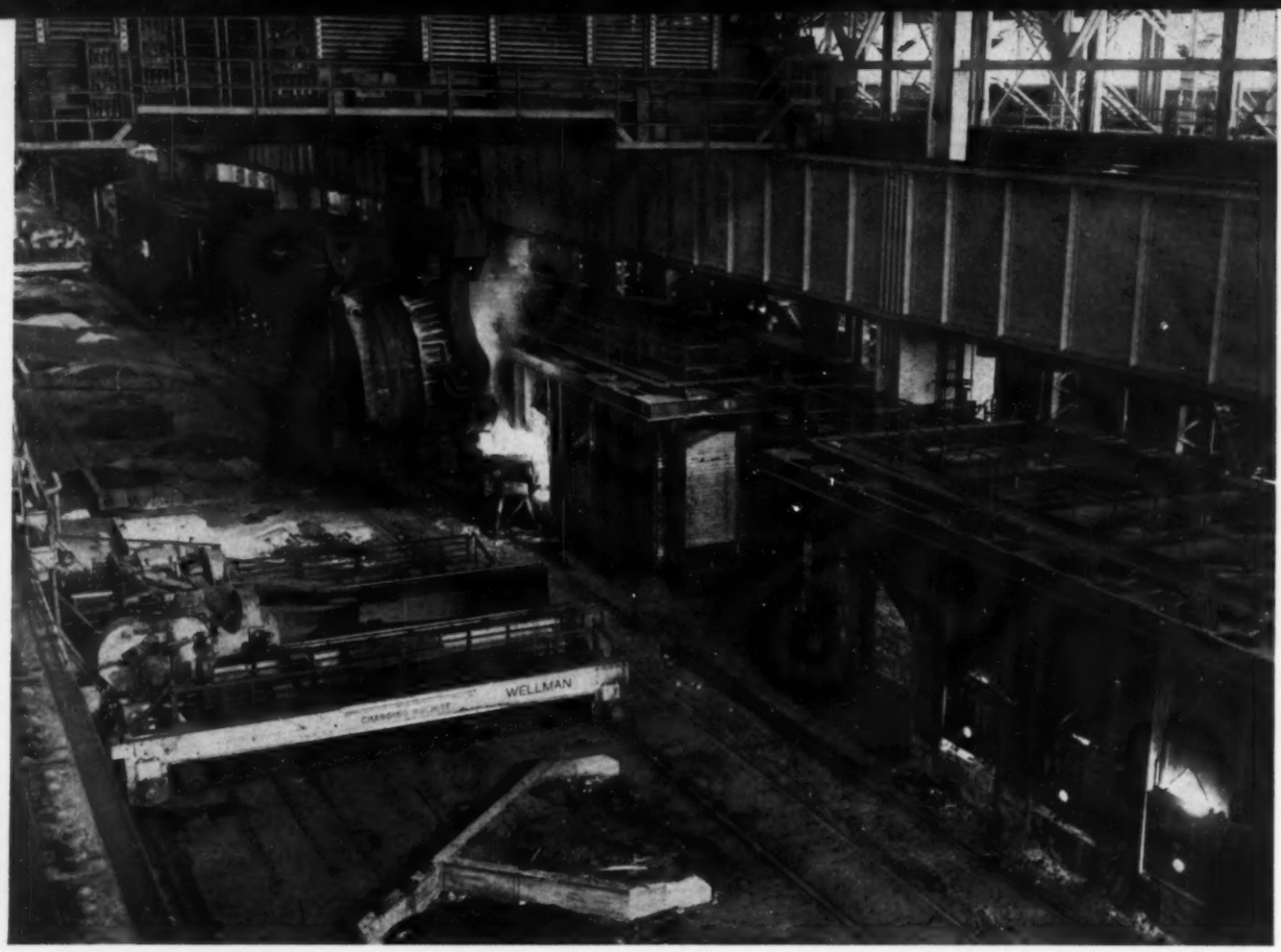
Limestone consumption is 575 lb per ton of iron.

Of unusual interest in this furnace installation is the fact that the only materials coming to the blast furnace other than by belt conveyors are open hearth slag and mill scale, which are brought in by railroad cars and handled by a small skip working between a depressed track hopper and the blast furnace bins.

OPEN HEARTH

Six open hearth furnaces comprise the main steelmaking capacity, each rated at 185 tons. Five of the furnaces are stationary, while one is a tilting design. The furnaces are 80 ft long, overall, with hearth dimensions of 17 ft 3 in. x 43 ft 6 in. giving a total area at the foreplate of 750 sq ft (4.05 sq ft per ton). The bath depth at the center of the furnace is normally 2 ft 9 in. below the foreplate.

The furnace hearth, totaling 36 in. in thickness, is constructed of 2 in. of insulating concrete, 9 in. of firebrick, 9 in. of chrome brick, 5 in. of a chrome base ramming mixture, and 11 in. of magnesite. The backwall is of sloping construction, and the sprung arch roof



Steel making facilities consist principally of six 185 ton basic open hearth furnaces of 80 ft overall length, with hearth dimensions of 17 ft 3 in. x 43 ft 6 in.

is 15 in. thick with 18 in. ribs. The venturi throats are 12 ft wide x 5 ft 9 in. high, giving an area of 61.58 sq ft. Each uptake is 6 ft 4½ in. wide x 7 ft long, with an area of 44.62 sq ft. Slag pockets are 13 ft 10½ in. wide x 19 ft 6 in. long.

Regenerator chambers, 30 ft x 18 ft x 17 ft, are of single construction with sprung arch roof 13½ in. thick and insulated with 2 in. of insulating block and ½ in. of cement. The chamber contains checkerwork 13 ft 4 in. deep, of a patented design using notched brick to form an interlocked structure and forming wells in the top part of the checkerwork by throwing two adjacent flues together. The brick is preponderantly 10 in. long, with some 11¼ in. and 13½ in. lengths used forming the wells. Vertical checker flues are 7½ in. x 7½ in. Wells 1 ft 5½ in. long x 7½ in. wide x 3 ft 3½ in. deep are left in the top of the checkerwork and provide horizontal passages through which gases may reach the vertical flues. The checkerwork shows the following figures for each end of the furnace:

Total free area of flues, sq ft	287
Total brick (9 in. equivalents)	36,058
Total brick weight, lb	252,406
Volume of checkerwork, cu ft	7,048
Solid volume of brick in checkers, cu ft	2,112
Total heating surface, sq ft	28,145
Heating surface, sq ft per ton	152
Checkerwork volume, cu ft per ton	38.3

Three checker flues, each 4 ft 10½ in. wide x 3 ft 7 in. high x 30 ft long, run the length of each regenerator chamber bottom and merge into the furnace flue, 5 ft 6 in. wide x 5 ft 6 in. deep, which extends 40 ft 6 in. to the stack flue. The latter flue is 5 ft 6 in. wide x 7 ft 3 in. high x 68 ft 9¼ in. long.

Two fire-tube waste heat boilers are provided (on No. 1 and 2 furnaces). These units each contain 7958 sq ft of heating surface, and are rated at 13,000 lb of steam per hr at 200 psi pressure, 450 F total temperature. Induced draft fans have a capacity of 99,000 lb per hr of gas at 1350 F.

Each furnace is provided with a stack 175 ft high, of brick-lined and insulated reinforced concrete, with inside diameters of 11 ft 5½ in. at the bottom and 6 ft at the top. Outside diameters are 13 ft 6½ in. at the bottom and 7 ft 4 in. at the top. These stacks were designed to withstand earthquakes and are equipped with lightning rods.

The furnaces are fired with coke oven gas and oil, in respective proportions of 35 and 65 per cent. Air is supplied to the furnaces under forced draft, and the main furnace damper is automatically operated to maintain furnace pressure. Automatic control is also provided for fuel oil temperature and coke oven gas pressure. The steam valve to the oil burner is the main control on the furnace. Its operation (by hand) automatically shuts off, through the action of pressure regulating valves, the fuel oil and gas, and at the same time, purges the burner. Furnace reversal is entirely motor operated, actuated from a push button.

The hot metal charge to the open hearth averages 50 per cent, ranging 45-60 per cent, with a flush slag being used with the high iron charges. Fuel consumption averages 3,800,000 Btu per ton of ingots produced. Average consumptions of various commodities run as follows:

	Lb per ton of steel
Limestone	190
Burnt lime	12
Dolomite, raw	38
Dolomite, burned	42
High carbon 80 per cent ferromanganese	14.6
Ferrotitanium	.4
Sinter	96.6
Ore	20
Ferrosilicon, 50 per cent	4
Ferrosilicon, 15 per cent	3

Ingot sizes for forging steels range 22 x 24 in. to 26 x 26 in. and are double-poured in hot-topped molds. Slab ingots for plate are poured in the following sizes: 12 x 30 x 60 in., 12 x 30 x 66 in., 14 x 38 x 66 in., 17 x 42 x 66 in. and 21 x 42 x 84 in. Bottom pouring is done on the buggies (4 large ingots, 6 small ingots per buggy), the pouring setup being in a straight line. The fountain is in the center of the sprue plate with an equal number of molds on each side. The diameter of the fountain is 4 in., while the runners going out on each side are 2¼ in. A 1½ in. ladle nozzle has been found best for this work.

Six parallel building bays house all of the open hearth facilities. The furnace bay is 900 ft long x 72 ft wide. Two 10 ton charging machines and a 125/30 ton hot metal crane operate in this bay. The pouring floor, 900 ft long x 74 ft wide, is served by two 250 ton ladle cranes and contains three pouring platforms. Basket pouring facilities are provided. In this arrangement the secondary ladle is on a gantry and moves over the molds so that the latter need not be moved until the ingots have solidified. A stopper rod assembly station and dryer is provided between No. 4 and 5 furnaces. At one end of the building is a transfer over which a ladle of molten metal may be moved back from the pouring floor into the furnace bay for duplexing operation.

At this same end of the building there is an electric arc furnace with a shell diameter of 12 ft 3¾ in. and nominally rated at 15-20 tons. This furnace uses 16 in. electrodes and is supplied with power from a 9375 kva three-phase transformer operating on the 6900 volt, 50 cycle distribution system. The furnace is in regular production, turning out 18 ton heats of basic steel for forging ingots in 6 hr with a power consumption of 600 kwhr per ton.

At the opposite end of the open hearth building is an 800 ton hot metal mixer with scale. Iron comes to the mixer from the blast furnace in 150 ton closed type ladles, while 90 ton hot metal ladles carry it from the mixer to the open hearth furnaces.

Immediately adjacent to the pouring floor is another building bay, 33 ft wide x 900 ft long, into which drags of ingot molds may be placed to cool. Flanknig this is the mold preparation building, a bay 80 ft wide x 700 ft long, in which there are three working platforms, one used for setting up sprue plates and molds for bottom pouring, one for mold spraying, and one for hot topping the molds. Two 15 ton cranes serve this bay. Facilities are also provided for mold dipping and heating.

One of the open hearth furnaces is of tilting design, giving added flexibility of operation.

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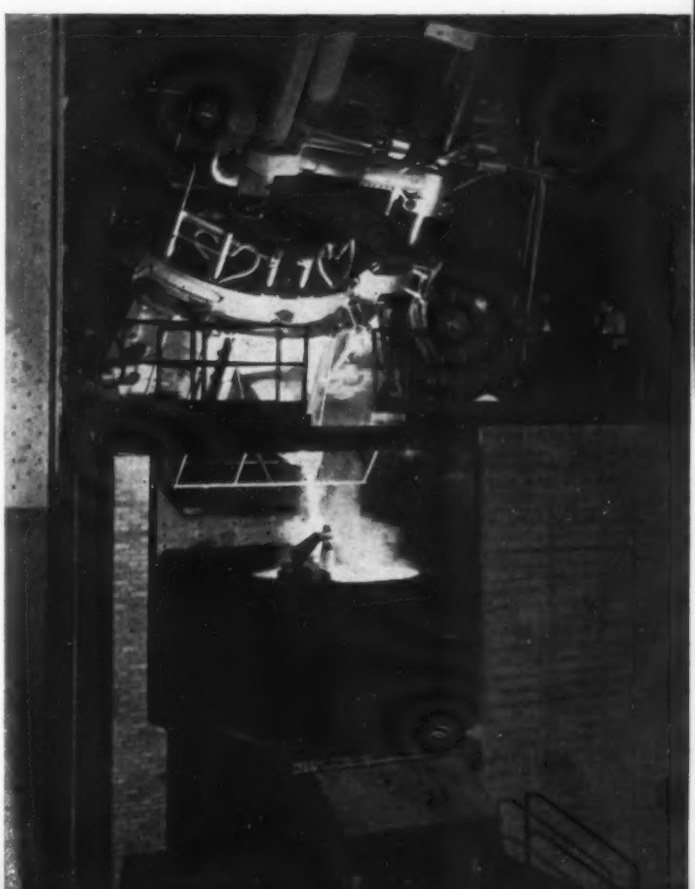
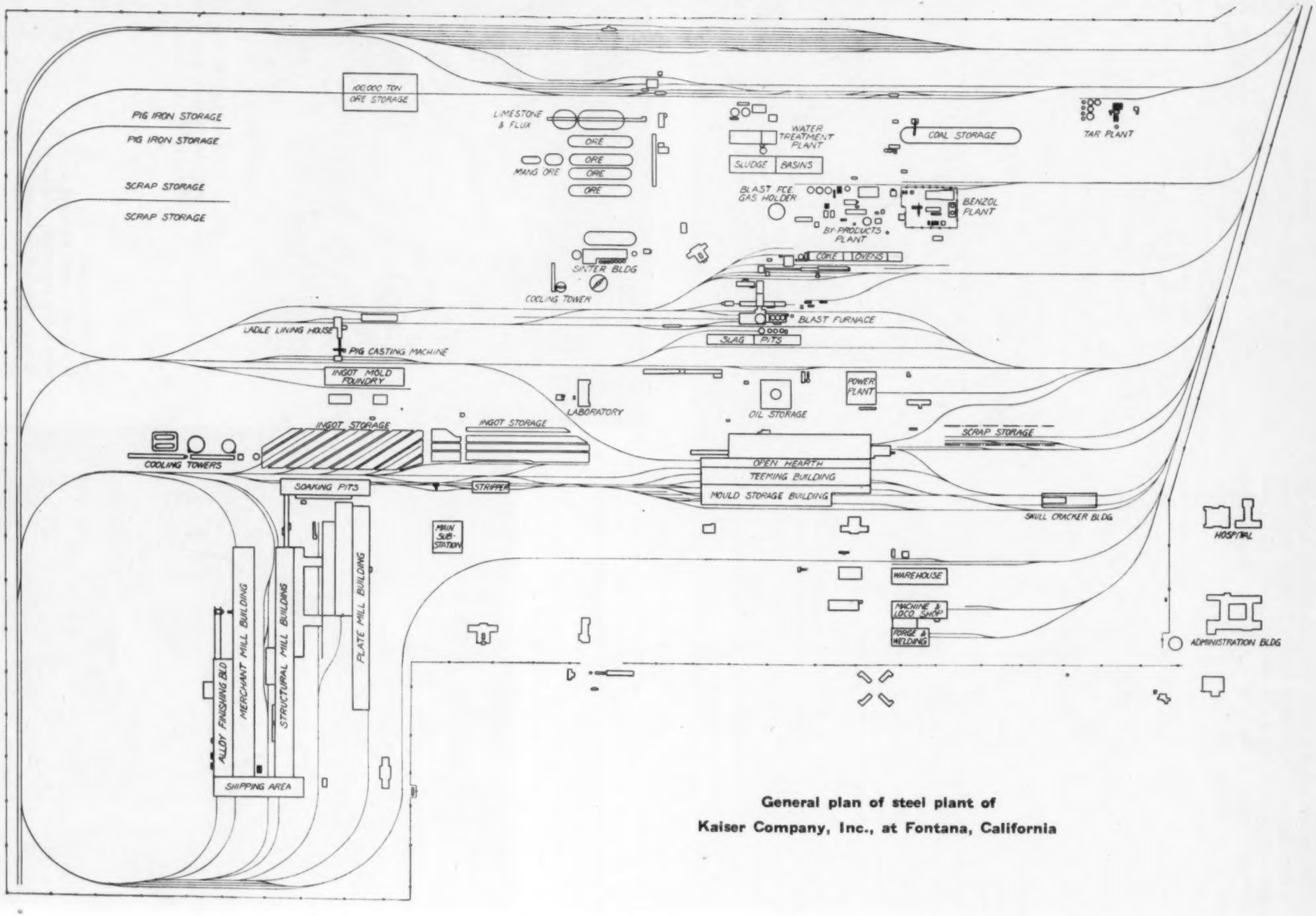


One electric furnace, 12 ft 3¾ in. in diameter and powered by a 9375 kva transformer, produces 18 ton heats in six hours.



General plan of steel plant of Kaiser Company, Inc., at Fontana, California

Next to the furnace building on the charging side is a 45 ft bay which is used principally as storage for alloys and miscellaneous materials, and paralleling this is the stockyard, an 85 ft bay 750 ft long served by two 10 ton cranes equipped for either bucket or magnet operation. Part of the stockyard is roofed so that all materials except scrap are under cover. The bins for limestone and feed ore are each 55 ft wide x 100 ft long x 23 ft deep. The scrap area is 33 ft wide. The remainder of the building width is taken up by an elevated platform at charging floor level, on which there are two railroad tracks with crossovers into the furnace building. Thus, scrap, limestone, ore, etc., may be loaded directly into charging boxes and the drag of buggies then shifted onto the charging floor on the same level. Charging cars and boxes are of welded construction and equipped with anti-friction bearings. The boxes (four per car) are each of 32 cu ft capacity.

The buildings are of flat roof design, in 25 ft bays, one low bay alternating with three high bays. Gravity type ventilators are provided in the roof, which, with the open bottoms of the side walls, keep the building well ventilated.

Located between the open hearth building and the soaking pits is the stripper building containing a 200 ton stripper crane. Also convenient to the open hearth are a cinder dump (80 ft x 150 ft) served by a 15 ton crane, and a skull cracker (80 ft x 150 ft) with a 40 ton crane

PLATE MILL

The first rolling unit to go into operation in the new plant was the 110 in. two-stand tandem mill consisting of a two-high roughing stand and a three-high finishing stand with the necessary tables, shears, levelers, etc. The mill, which is designed to roll plates ranging 3/16-1 in. thick and up to 96 in. wide at a rate of 45-60 tons per hr, started operation August 19, 1943.

To date the mill has rolled directly from bottom-poured slab ingots 12-24 in. thick, which are heated in a battery of 12 pit furnaces. These pits are 13 ft 6 in. square and are fired with coke oven gas through a single large burner in the center of the hearth. Refractory recuperators preheat the air used for combustion and a complete complement of automatic controls for temperature, furnace pressure and gas-air ratio is provided. Space has been left for the future installation of two continuous slab heating furnaces should they be desired. There are also six preheating pits, each of the same holding capacity as one soaking pit and capable of heating ingots up to 1800 F.

The pit furnaces are arranged in a double row at right angles to the plate mill building, and a side-tilting ingot car brings the ingots to the mill table.

The first unit of the mill is a vertical edging stand, in which the rolls, 44 in. in diameter x 30 in. long and operating in roller bearings, are driven by a 1500 hp, 80-240 rpm, 750 volt d-c reversing motor. Clearance between the vertical rolls is adjustable up to a maximum of 110 in. through the action of two 50 hp motors. Feed and delivery rollers to the edger are driven by two 15 hp motors.

Beyond the edger at a distance of 27 ft 5½ in. is a two-high reversing roughing stand with rolls 44 in. in diameter x 110 in. body length, operating at speeds of 345-855 fpm. Tapered oil-film bearings are used on the roll necks in this unit. A maximum roll lift of 31 in. is provided, the movement being actuated by mill screws 16 in. in diameter of 1½ in. pitch, driven by two 100 hp mill type motors. The top roll is balanced by hydraulic pressure at 500 psi. Side guards on this stand are driven by 25 hp motors, and feed and delivery rolls by 35 hp motors.

The main drive of the slabbing mill is of twin-motor

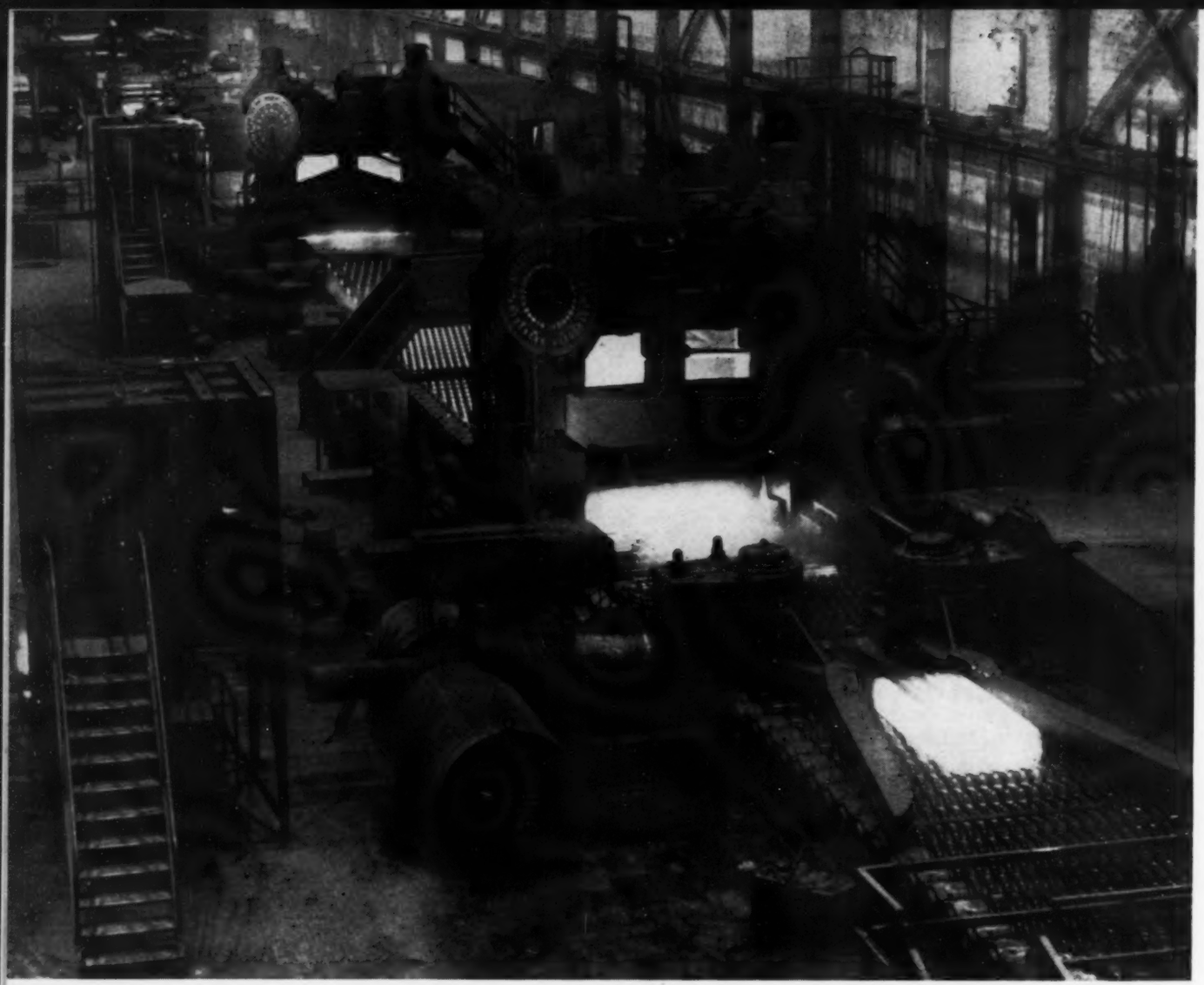
Twelve pit furnaces, in conjunction with six preheating heat ingots for the plate mill as well as for the 36 in. roughing unit of the structural mill.

design, consisting of two 3500 hp, 30-75 rpm, 750 volt d-c reversing motors, one connected directly to each mill roll. Power for the twin drive and for the edger drive is provided by a flywheel motor-generator set consisting of two 3000 kw and one 1250 kw generators, all 750 volt d-c.

A three-high 40 in. x 26½ in. x 110 in. plate finishing stand is located 100 ft beyond the slabbing stand. The top and bottom rolls in this stand run in composition roll neck bearings, and their maximum opening is 14 in., the screw-down mechanism being similar to that on the slabbing mill except that it operates under variable voltage control. The roll balance is operated by a 500 psi oil-hydraulic system and oil-hydraulic power at 1400 psi shifts the middle roll up and down. Housing posts are 28 in. x 31 in., designed for a maximum separating force of 9,600,000 lb.

Mill spindles 12 ft long x 22 in. in diameter connect the top and bottom rolls to a three-high pinion stand using double helical pinions of 6.187 in. circular pitch and 72 in. face. Top and bottom pinions are 47¼ in. in diameter with 24 teeth, the middle pinion 31½ in. diameter with 16 teeth.

The plate mill is driven at speeds of 280-840 fpm by a 7000 hp, 40-120 rpm, 750 volt d-c variable speed motor. This motor receives power from a motor-generator set consisting of two 3000 kw 750 volt d-c generators and a 6000 hp, 6600 volt motor.



General view of 110 in. plate mill, with vertical edger in foreground, followed by two-high reversing slabber and three-high finishing stand. The slabber is driven by a twin-drive composed of two 3500 hp motors, the finisher by one 7000 hp motor.

From the ingot buggy track to the vertical edging stand is a distance of about 173 ft. Four table sections 28-38 ft long are driven at a speed of 360 fpm through line shafts by 50 and 75 hp motors, one drive to each section. A fifth section, 23 ft 4 in. long and driven at 350-700 fpm by a 100 hp motor under variable voltage control, serves as an entry table to the edging stand and works in conjunction with the entry and delivery tables of the slabbing mill.

On each side of the two-high slabber are table sections 13 ft 4 in. long, each driven at 350-700 fpm. The entry side is driven by two 50 hp motors and the delivery side by one 75 hp motor, all under variable voltage control. A turntable mechanism is installed in each of these tables so that broadside rolling may be done to increase the ingot width.

A tilting table, 32 ft 5 in. long, is installed on each side of the three-high finishing stand. These tables are driven at speeds up to 500 fpm by two 100 hp motors under variable voltage control. The tables are tilted through articulated levers actuated by two 150 hp mill type motors and are unusual in that they carry motor-operated sideguards, which are useful in holding the plate in the center of the mill

Beyond the three-high stand, mill tables extend for a distance of about 286 ft. In this line are located a dividing shear and a light roller leveler which operates at a speed of 152-455 fpm. Immediately following the leveler, a chain-and-dog type transfer and cooling bed 75 ft long carries the plates to parallel table lines located in an adjoining building bay. This bay is 100 ft wide x 1100 ft long and contains two parallel cooling tables. The first table contains a heavy roller leveler and a rotary side-trimmer. The second table contains an end shear, shear gauge, inspection turn up and scale table, and is in line with a castor bed containing two side shears. Unloading skids are located at various points along this table in order to facilitate handling the product. Beyond the end of the cooling tables, space is provided for storage and shipping. A flame-cutting unit is also installed in this building.

Hydraulic descaling sprays are installed, top and bottom, at the entry side of the two-high stand and on the bottom entering side and the top of the back pass in the three-high stand. The sprays operate at a pressure of 1200 psi supplied by two 600 gpm centrifugal pumps.

This mill is, for the greater part, rolling ship plate ranging 3/16 in. x 80 in. to 1 in. x 100 in. The average

gauge is .45 in. A production rate of 65 tons per operating hour has been maintained. Daily production has reached 1500 tons finished weight and monthly production, 32,500 tons.

Extending along one side of the mill building is the motor room, 65 ft x 375 ft. Here are located the main drives and their motor-generator sets previously mentioned, together with control equipment, main and auxiliary exciter sets, etc. Two 600 kw, 250 volt motor-generator sets are installed for the variable voltage control systems on the two-high front and back tables and on the three-high screwdown and front and back tables. The 1000 kw motor-generator sets supply 230 volt d-c power for other mill auxiliaries.

Power is brought to the motor room at 6900 volts, which is the operating voltage of the large units. A-c auxiliaries operate on 460 volt power supplied by two load distribution centers in the motor room, each containing a 1500 kw, 6900/480 volt transformer. All switchgear is of the metal-clad type.

All rotating machinery is cooled by a recirculating down-draft ventilating system. At the end of the motor room is a roll shop and an electric repair shop in which are located three air compressors.

STRUCTURAL MILL

The structural mill consists of two principal units: a 36 in. roughing mill and the 29 in. mill. The 36 in. mill is a two-high reversing unit driven by a 5000 hp, 700 volt, 50-120 rpm motor through forged steel pinions of 36 in. pitch diameter and universal type mill spindles with motor-operated spindle shifters. The motor receives power from a motor-generator set consisting of two 2500 kw, 700 volt generators and a 4500 hp, 6900 volt, 490 rpm wound rotor induction motor with flywheel.

The alloy steel rolls in this mill are 36-37½ in. in diameter x 82 in. body length, and have roll necks of 22 in. diameter operating in composition roll neck bearings, lubricated by water. The top roll is balanced by a counterweight. A maximum roll lift of 32 in. is provided through the action of a 150 hp motor driving the screwdown mechanism, which operates under adjustable voltage control. Mill screws are of 11 in. diameter and 1¾ in. pitch. Maximum speed of roll lift is 10.46 fpm.

The cast steel housings of this mill are of open top design, facilitating roll changing, which is accomplished by overhead crane. The top assembly of the mill is lifted as a unit.

Manipulators on each side of the mill are driven by two 100 hp motors, also operated under variable voltage control, as are the front and back mill tables.

The 36 in. mill motor room, 175 ft long x 50 ft wide, houses the main drive motor and motor-generator set previously mentioned, with their switching and control equipment. A 550 kw, 250 volt motor generator set is also located here for the variable voltage control of the screwdown, manipulators and tables. A 500 kva unit substation supplies 460 volt a-c power for auxiliaries. All switchgear is of the metal-clad type. All rotating equipment is cooled by down-draft recirculation of air in a closed system containing surface type coolers.

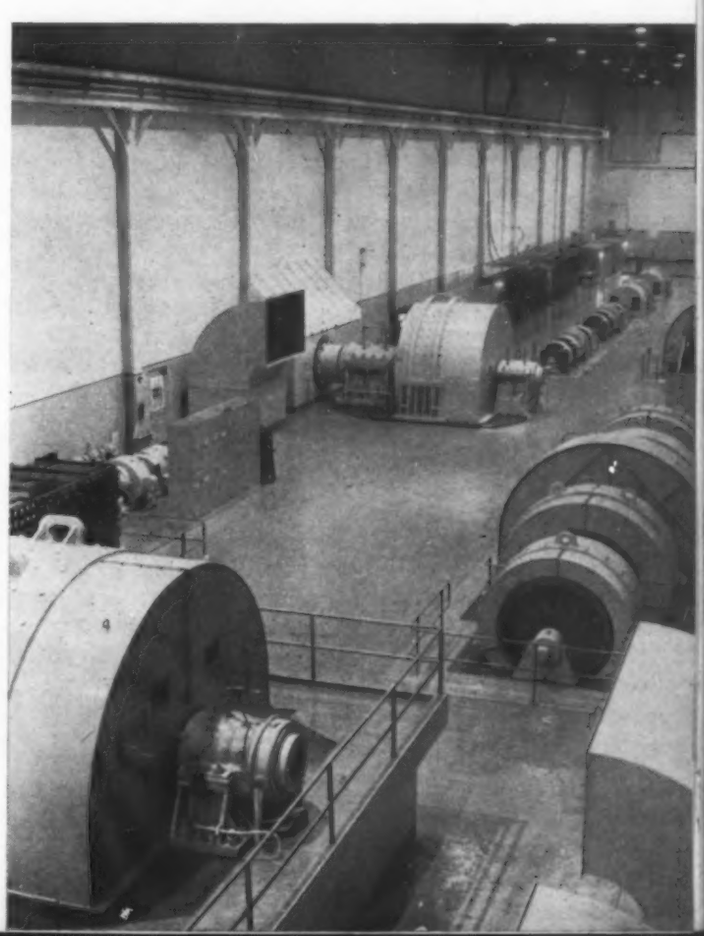
Approximately 135 ft beyond the 36 in. mill is a hydraulically operated bloom shear of upcut design, capable of cutting sections up to 300 sq in. Crops are chuted on to a conveyor which carries them from the shear into buckets placed in a pit located just outside of the mill building. Two buckets are located on a car so that one may be in use while the other is being emptied.

Immediately following the bloom shear is a 20 ft hot bed transfer to the left of the mill line, over which blooms may be pushed to the east billet yard, and to the right is a 30 ft hot bed transfer leading to the west billet yard.

The 29 in. mill, located about 375 ft from the 36 in. mill, is composed of a roughing stand, an intermediate stand and a finishing stand, located side by side (16 ft 6 in. center to center) and all driven by a single 5000 hp, 800 volt, 70-150 rpm d-c motor. The first two stands are three-high, and the finisher is two-high. Traveling tilting tables 50 ft long, two on the entry side and one on the exit side, handle the steel into and out of the mill stands. Sixty foot traveling trailer tables follow the tilting tables. Chutes on both sides of the mill catch lengths that overtravel the trailer tables.

Housings are of cast steel and open top design. The top and bottom rolls of the three-high stands and the top roll of the two-high stands are adjustable through manual operation of screws. All top rolls are spring balanced. Rolls, with bodies 30¼ in. in diameter x 68 in. long, operate in composition bearings, water lubri-

Plate mill motor room, with finishing stand drive at center, main motor-generator sets at right, and part of twin-drive at lower left.



At present the 36 in. reversing mill is used to break down ingots and also to reroll blooms as a rougher for the structural mill.

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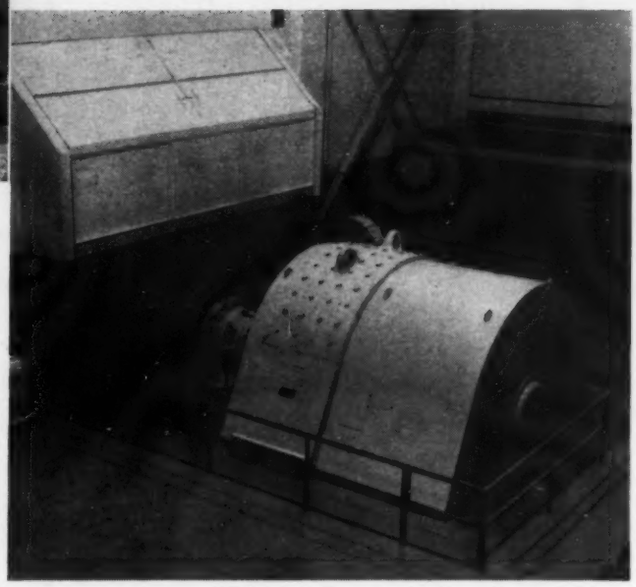
The 36 in. mill is driven by a 5000 hp, 700 volt, 50-120 rpm reversing motor.



cated. Roll necks are 19 in. in diameter. Roll adjustments are made through motor operated mill screws which are 9 in. in diameter with 1 in. pitch.

The three-high pinion stand contains cast steel, double helical cut pinions of 29 in. pitch diameter, running in babbitted bearings.

Descaling sprays are installed top and bottom on the entry side of the rougher and on the top pass of the intermediate stand. Water is supplied to the sprays from a 15 in., 17-stage vertical centrifugal lump rated at 200 gpm, 1000 psi. Steam jets blow off loose scale at the lower pass of the rougher, the top pass of the intermediate stand, and the entry of the finisher.

The 29 in. mill motor room, 50 ft x 150 ft, houses the main drive motor and the motor generator set which furnishes power to it, a unit composed of two 2000 kw, 800 volt generators driven at 500 rpm by a 5600 hp, 6900 volt synchronous motor. It should be noted that the 29 in. mill operates under variable speed control but not reversing. In this motor room there is also a 1500 kw mercury arc rectifier which furnishes 250 volt d-c power for auxiliary motors. A 500 kva, 460 volt unit substation in this room supplies a-c power for auxiliaries in the area. A closed recirculating ventilating system cools the rotating electrical machinery. There is another rectifier unit of 1000 kw capacity located in a control room near the mill cooling bed, also supplying d-c power for auxiliaries.

From the finishing stand the runout table proceeds to a 60 in. sliding frame hot saw and saw gauge, and on to a cooling table 70 ft x 49 ft 9 in., over which the product may be moved to another table to the left of the mill line. This table leads to a roller straightener and on to an inspection bed 70 ft long x 31 ft 8 in. wide containing a turnover rig. From the inspection bed, products proceed through a cold shear and on to an assembly and piler bed. This bed is located in the shipping yard, 110 ft x 450 ft, which runs across the ends of the structural and merchant mills. A crane of special design is installed here for piling shapes 5-60 ft long, using magnets attached to the trolleys. The crane has a span of 77 ft, and carries two 3 ton trolleys. A friction saw is also installed in the shipping building for cutting structural sections to length.

Two 15 ton double trolley cranes serve the entire yard.

Another outlet from the 29 in. mill is provided by a billet transfer 60 ft long x 42 ft 5 in. wide located near the cooling bed mentioned above and leading to the west billet yard. This outlet is used principally for billets and rounds. Near the discharge cradles of this transfer in the west billet yard are two large slow cooling pits, each of which can be divided by removable bulkheads into ten pits 9 ft x 9 ft x 9 ft. Gas burners are provided on these pits in order to give complete control of the cooling rate of the product.

Reheating facilities in the structural mill consist of two duplicate furnaces of the familiar triple-fired, continuous design. Hearth dimensions are 23 ft x 79 ft 6 in., and each furnace has a nominal capacity of 80 tons per hr when heating cold steel. They are fired with coke oven gas, and air for combustion is preheated in tubular silicon carbide recuperators. Complete automatic control of temperature, fuel-air ratio and furnace pressure is provided on each of the three firing zones. These furnaces are not placed side by side as is usually found in such cases. One furnace (No. 1) is located just ahead of the 36 in. mill while the second (No. 2) is just ahead of the 29 in. mill. The reasons for this will be apparent from the following discussion of rolling practice. They are so placed that their charging skid beds project back into the east billet yard, while the discharge ends are, of course, along the mill table.

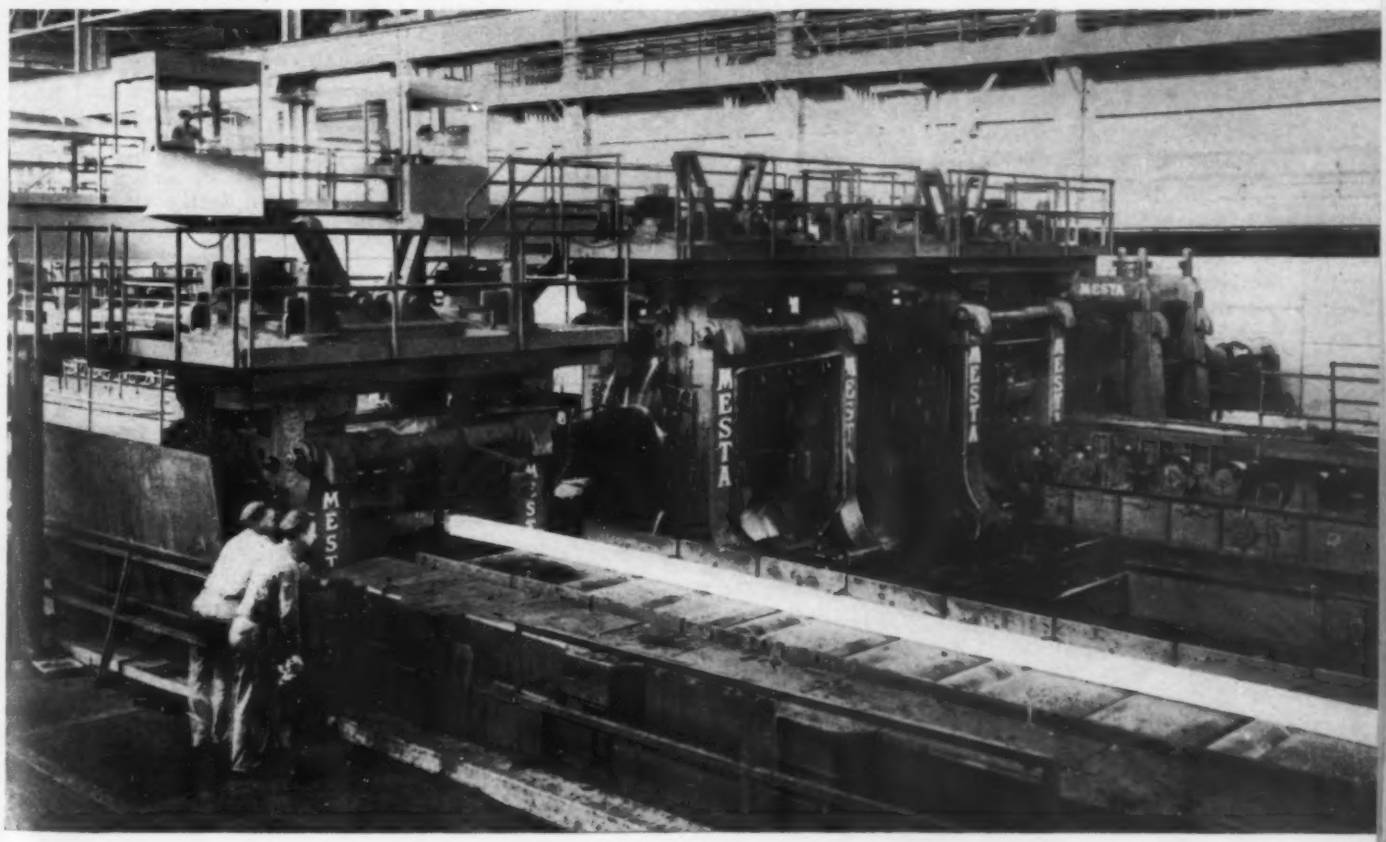
Because of the absence of a large blooming mill (for which space has been left preceding the 36 in. mill) the 36 in. mill at present must do double duty, taking ingots

Of upcut design, the bloom shear is hydraulically operated and capable of cutting sections up to 300 sq. in The transfer in the foreground leads to the east billet yard.

20 in. x 20 in. to 26 in. x 30 in. directly from the soaking pits and breaking them down into blooms or beam blanks, and then, when necessary, acting as a rougher for the 29 in. mill Ingots are brought to the mill from the soaking pits (previously described in connection with the plate mill) in an ingot car which operates in a covered runway about 330 ft long. This runway, at right angles to the soaking pit building, is a temporary link necessitated by the space left for the future large blooming mill. Products leaving the 36 in. mill are blooms ranging from 4 in. x 4 in. to 14 in. x 14 in. squares, slabs up to 28 in. wide and blanks for structural shapes up to 24 in. If the product from the 36 in. mill is intended for rerolling in the structural mill it is transferred to the east billet yard, conditioned and reheated in one of the two furnaces previously mentioned. If intended for the merchant mill, the product is transferred to the west billet yard.

When operating as a rougher for the 29 in. mill, the 36 in. mill receives reheated material from the No. 1

Three stands side by side (two are three-high, one two-high) form the 29 in. structural mill. Products from this mill include beams and channels 5-20 in., angles 3½-8 in., and rounds and squares 4½-8 in.



reheating furnace and gives it 3, 5 or 7 passes, according to the structural section being rolled. This product, which includes the blanks for practically all beam and channel sections, then proceeds to the 29 in. mill without another reheating.

The 36 in. mill is stated to have a capacity of 70 tons per hr.

Squares, rounds and angle sections are generally rolled on the 29 in. mill from blooms reduced from the ingots in the original rolling on the 36 in. mill. These blooms are reheated in the No. 2 Furnace located near the 29 in. mill.

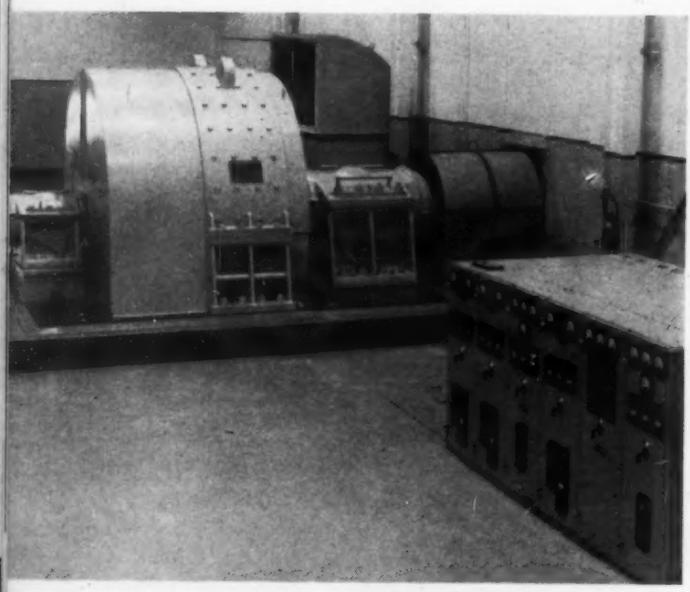
Whether rolling from its reheating furnace or from the 36 in. mill, the 29 in. mill gives the steel 5, 7 or 9 passes, according to the section being produced. Billets are reduced by the flat and edge method, while structural passes are of course closed. The 29 in. mill has a nominal capacity of 65 tons per hr, and the product range includes beams and channels from 5 in. to 20 in., angles 3½ in. to 8 in., and rounds and squares 4½ in. to 8 in. It is also planned to set up this mill for future rail production, which will require but little in the way of additional equipment. At present much of the product from this mill consists of billets for shell manufacture. In the nearby plant of Kaiser Industries, there are 5 rough machining lines and 8 heat treating lines for 155 mm shells, while one rough machining line and two heat treating lines for 8 in. shells are installed in the alloy finishing building adjoining the merchant mill.

From the foregoing, it may be seen that the east billet yard, which is 100 ft x 600 ft and served by two 25/10 ton cranes, is primarily devoted to the conditioning and storage of blooms or blanks from the 36 in. mill and intended for further rolling either in the 36 in. or 29 in. mills.

The west billet yard, 114 ft x 1250 ft with two 25/10 ton overhead cranes and a gantry crane, lies between the structural mill and the merchant mill and is used for blooms and billets from either the 36 in. mill or the 29 in. mill. Some of these are conditioned here for rerolling in the merchant mill, and some for direct shipment. This yard contains slow cooling pits, pickling facilities, and chipping, scarfing and inspection beds.

The structural mill building itself is 100 ft wide x 1250 ft long, of high-and-low bay construction with flat roof, and contains one 125/25 ton crane and two 25/10 ton cranes.

Adjacent to the structural mill and extending into the west billet yard is the roll shop, 50 ft x 200 ft, containing six roll lathes, two of 28 in., two of 42 in., one 50 in. and one 60 in. This shop does all the roll turning for the structural mill as well as the merchant mill. A 30 ton crane serves to handle the rolls in the shop, and a transfer track connects with the structural mill. There is also a truck road and a rail spur into the shop.



A single 5000 hp, 800 volt, 70-150 rpm d-c motor drives the 29 in. mill under variable speed, nonreversing control.

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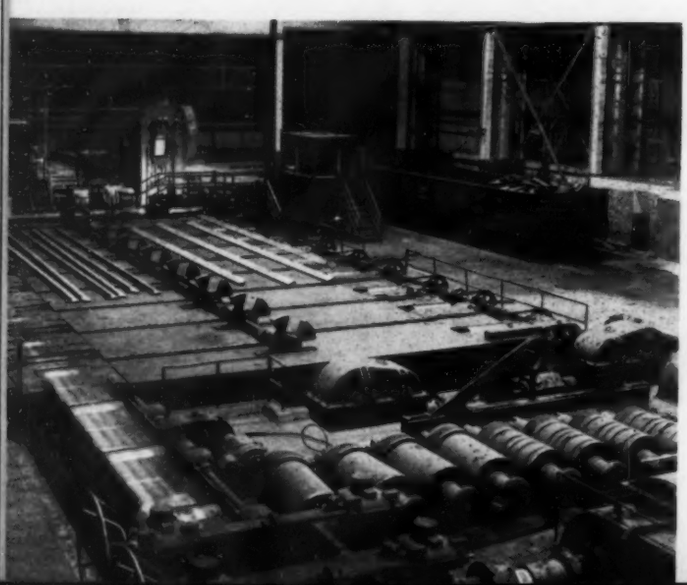
Structural products from the 29 in. mill pass over an inspection bed containing a turnover rig, and then proceed through a cold shear to a piler bed in the shipping yard.



MERCHANT MILL

The merchant mill, which just recently was placed in operation, is a 21-18-14-10 in. unit composed of 16 stands and 2 vertical edgers in a cross-country layout with continuous roughing. Billets from the west billet yard are placed on a skid bed which conveys them to the furnace charging table.

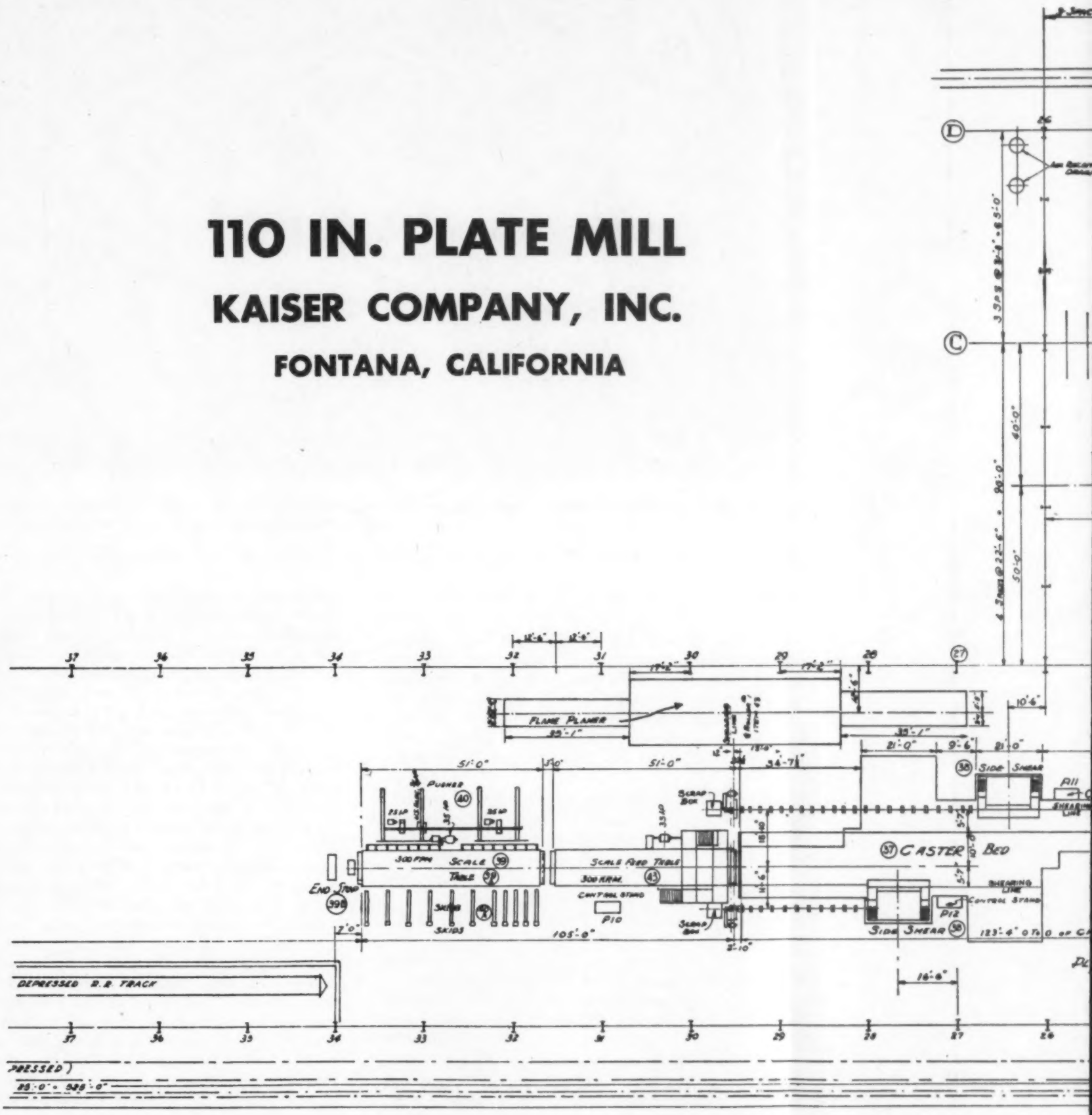
Reheating facilities for the merchant mill consist of one side-charge, side-discharge continuous heating furnace 33 ft wide x 50 ft 10 in. long with a sloping solid hearth. The furnace is top-fired with coke oven gas through two rows (6 burners per row) of semi-diffusion burners located in the discharge end wall, the top row being capacity burners and the bottom row, conditioning burners. The furnace is equipped with a tile recuperator, and with automatic temperature, combustion and furnace pressure controls. Draft is supplied by a stack 5 ft 6 in. in diameter x 135 ft high. Nominal furnace capacity is 56 net tons per hr. The furnace pusher moves the billets down over the hearth, while an ejector pusher pushes the front billet out through the side of the furnace onto the mill approach table, where it may be cropped or divided in a hot billet shear.

TECHNOLOGY DEPT.

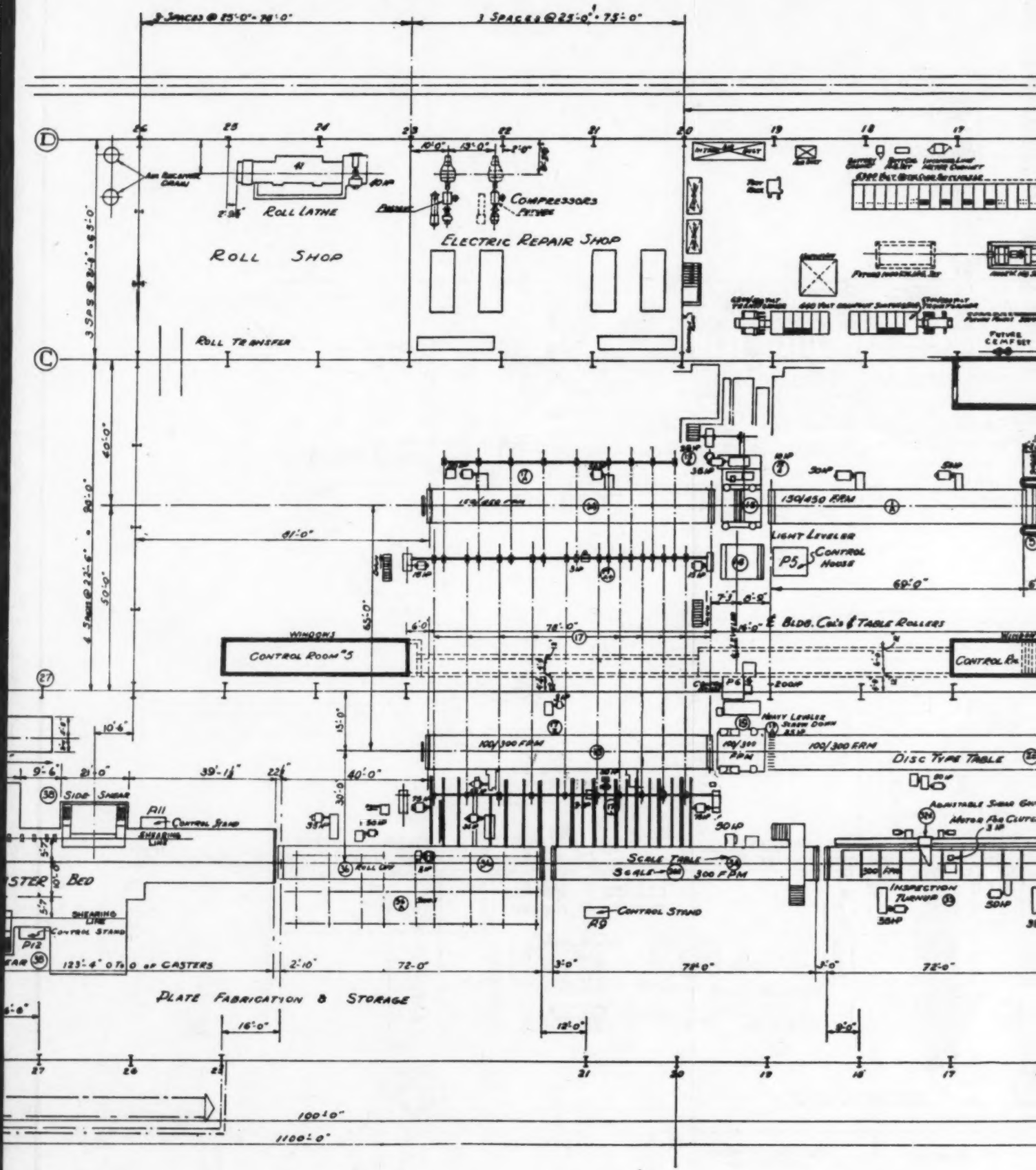
110 IN. PLATE MILL

KAISER COMPANY, INC.

FONTANA, CALIFORNIA



TECHNOLOGY DEPT.


ROLL SHOP
ELECTRIC REPAIR SHOP
ROLL LATHE
COMPRESSORS
ROLL TRANSFER
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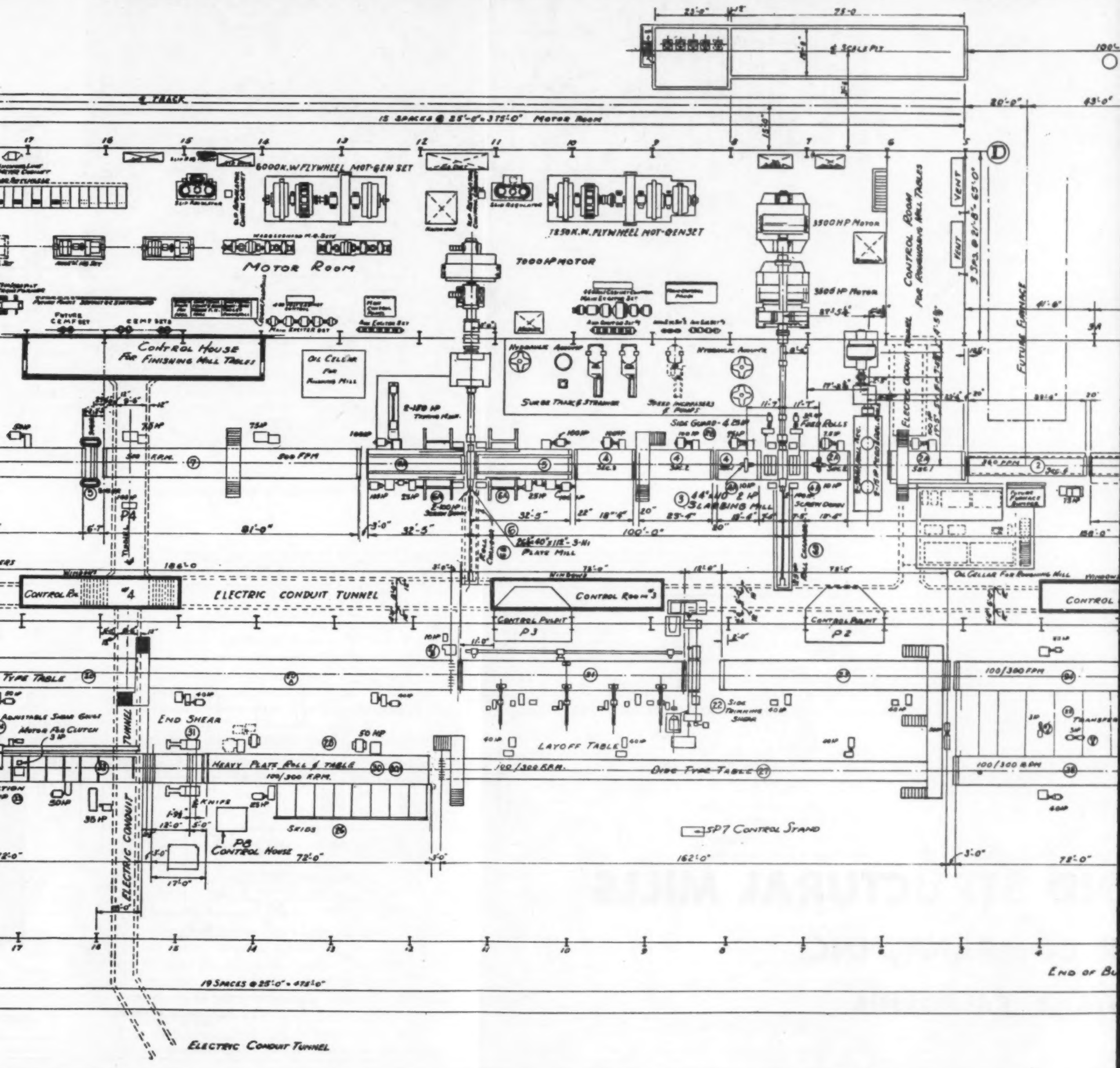
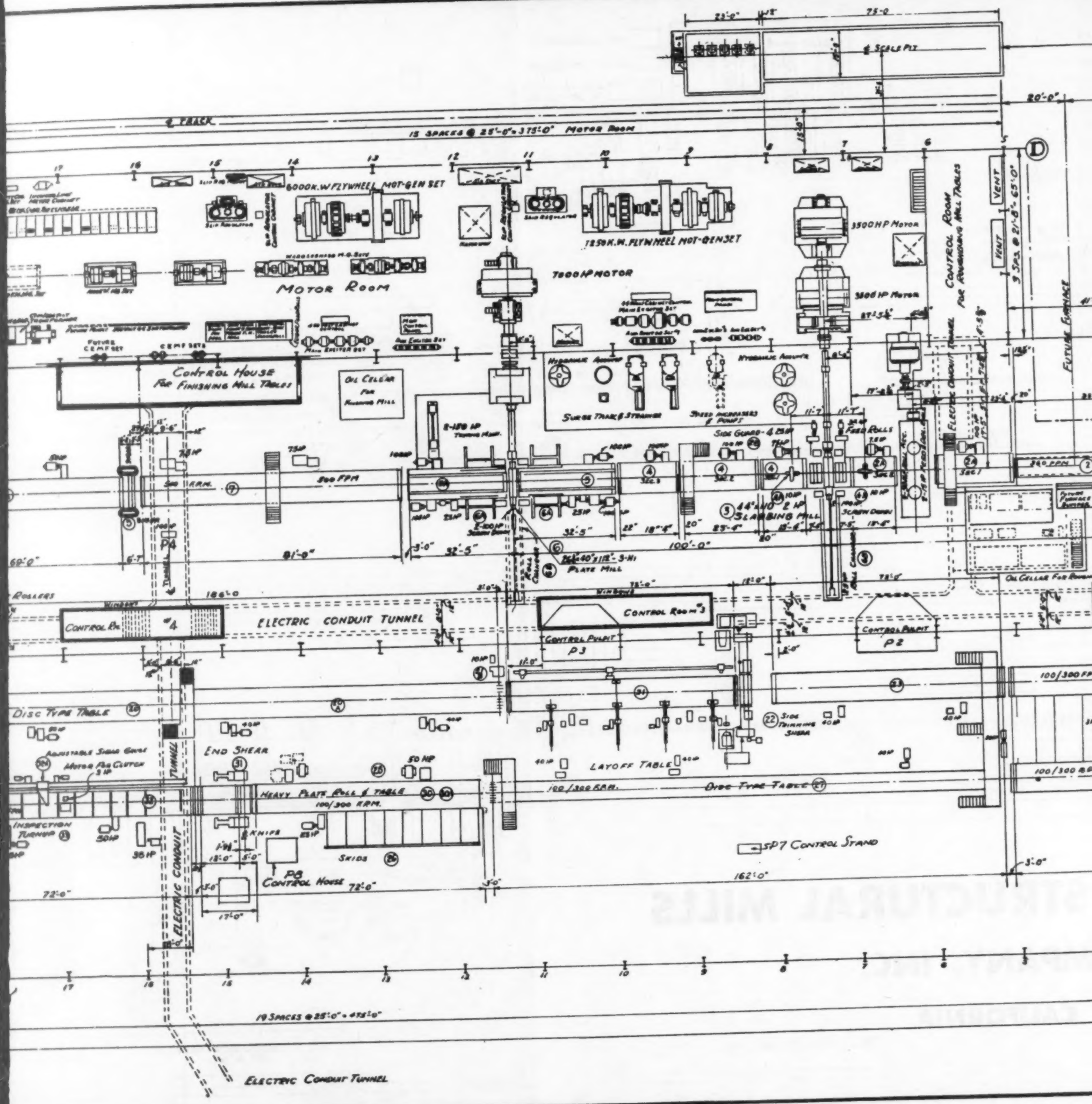
SCALE
CONTROL STAND
INSPECTION TURNOVER
PLATE FABRICATION & STORAGE
SIDE SHEAR
SHEARING LINE
CONTROL STAND
130/450 F.P.M.
100/300 F.P.M.
300 F.P.M.
50 HP
30 HP
20 HP
125'-4" O to O of CASTERS
72'-0"
100'-0"
1180'-0"

TECHNOLOGY DEPT.



TECHNOLOGY DEPT.

TECHNOLOGY DEPT



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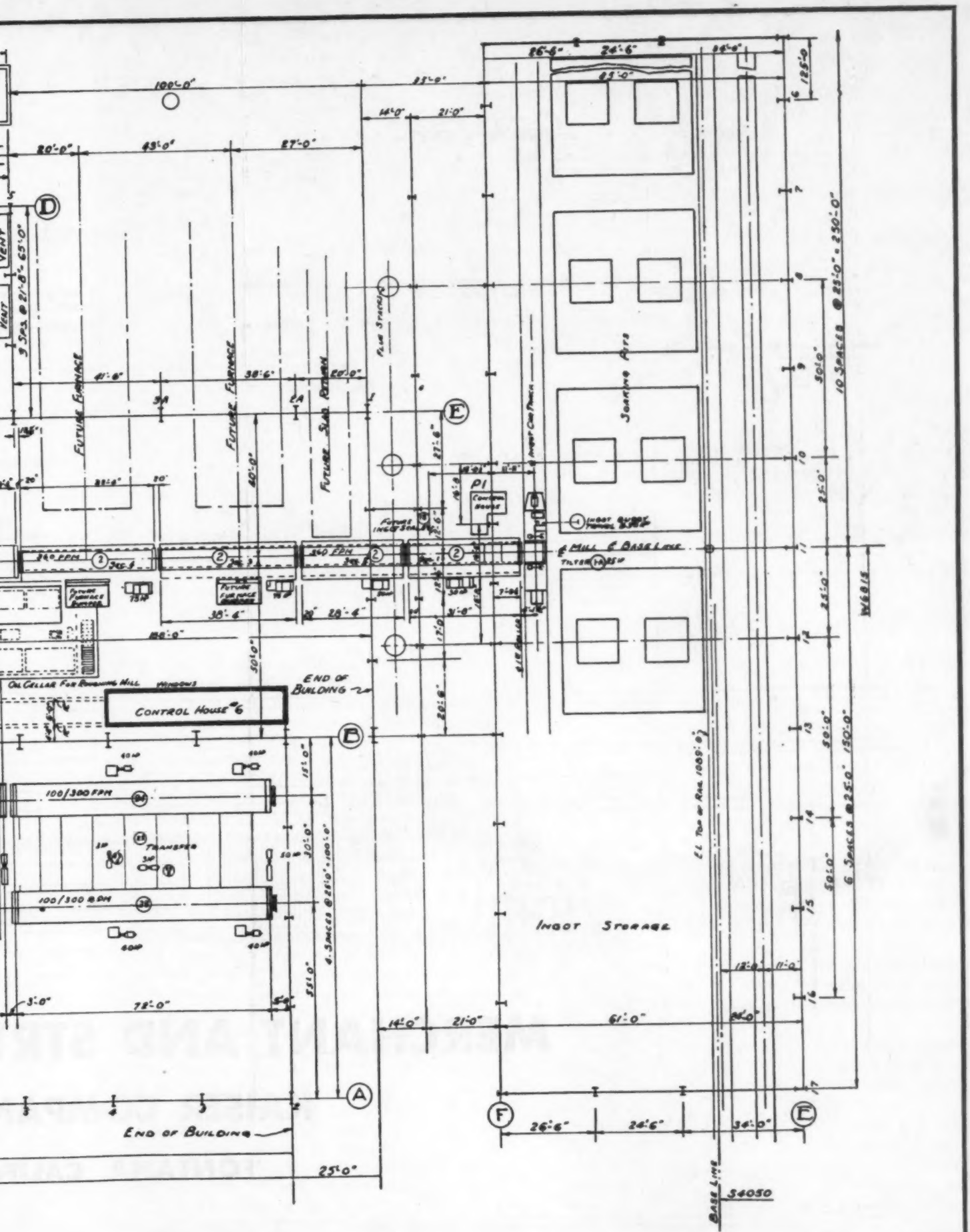

CONTROL HOUSE #6
END OF BUILDING
INGOT STORAGE
FUTURE FURNACE
FUTURE SOAK PITS
SOAKING PITS
100/300 FPM
240 FPM
10 SPACES @ 23'-0" = 230'-0"
6 SPACES @ 25'-0" = 150'-0"
4 SPACES @ 25'-0" = 100'-0"
3 SPS @ 21'-8" = 65'-0"
END OF BUILDING
25'-0"
72'-0"
61'-0"
26'-6"
24'-6"
34'-0"
S4050

The west billet yard, which is located between the structural mill and the merchant mill, contains slow-cooling pits, pickling facilities, and chipping, scarfing and inspection beds.

Details of the mill are set forth in the accompanying table and layout sketch. The billet first passes through a vertical edger, then through four 21 in. stands, through the second edger, and then through four 18 in. stands which complete the continuous roughing line. The spacing of these stands is given in the mill data table.

Leaving No. 8 stand, the steel may proceed either to No. 9 stand, which is in line with No. 8 and about 152 ft distant, or it may be transferred directly across to No. 11 stand. If the section is sufficiently small it may be looped from No. 8 stand to No. 11 stand. No. 9 and 10 stands are generally not used on small sections to be finished out of No. 14 or 16 stands, but are used on the larger sizes which are to be finished out of No. 12 stand.

Immediately following No. 9 stand is a flying shear, and the runout table leads to a pinch roll and piler. This outlet is used principally for large flats. If the product from No. 9 stand requires further reduction, a transfer following the stand moves the steel over to a parallel table approximately 12 ft distant which contains stands No. 10 and 11, spaced about 140 ft apart. Another transfer connects with No. 12 stand's table and as the product leaves No. 12 stand it may pass over the runout table, through a hot saw to a 120 ft cooling bed lying to the left of the runout. This bed is of the notch bar type, and can be changed over for flats. There is also a notch type cooling bed, cradle and scale located after the hot saw, used principally for alloy bars. A slow-cooling pit, 50 ft long x 8 ft wide x 6 ft deep, is located near this transfer. It is equipped with gas burners to aid in the control of the cooling rate.

If the steel from No. 12 stand needs still further reduction, it is passed through stands No. 13 and 14, transfers moving it to each of these stands. Leaving No. 14 stand, the runout table carries the product through a flying test bar and parting shear and on to a 250 ft cooling bed. This bed may be used either as notch bar or flat, and may also be used for pack annealing.

For small rod sizes, the steel leaving No. 14 stand is looped back through No. 15 and No. 16 stands, and then coiled on two pouring reels. A coil conveyor runs under the mill from the pouring reels to the wire department.

The cooling bed following No. 12 stand and that following No. 14 stand extend laterally to a common table line which contains a straightener and a cold bar shear.

As may be noted, this layout offers a high degree of flexibility. The mill has four principal outlets, respectively from No. 9 stand, No. 12 stand, No. 14 stand and No. 16 stand.

The housings in this mill are of open top design. Roller bearings are applied to the roll necks of the vertical edgers and the first 12 mill stands. The last four stands are equipped with composition bearings, lubricated by water. Roll adjustments are made through motor-operated screws on the first 12 stands and

Six roll lathes, of various sizes, provide roll turning facilities for the structural and merchant mills.

This cooling bed, which follows the 18 in. stands (No. 12 stand), is but one of the four outlets which give the merchant mill a highly flexible layout.

manually-operated screws on the 14 in. and 10 in. stands.

All mill pinions are of forged steel with helical cut teeth, and are provided with roller bearings. Reduction gears also have helical cut teeth and operate in roller bearings. Both pinions and gears are lubricated by a combination of dipping and spraying, with circulating oil systems.

Mill tables through the roughing train are driven through line shafts, and are equipped with roller bearbearings. Rollers in the rest of the mill tables are individually driven by a-c motors operating under variable frequency control.

Steel comes to the merchant mill in squares 4 in. to 7 in. or in slabs 2½ in. thick and 4-18 in. wide. The mill produces rounds ⅜-4½ in. in diameter, squares ⅝ in. to 3 in., flats 1¼-16 in. wide and .109-.5 in. thick, beams and channels up to 4 in., and angles up to 3 in. Reduction is by the oval-square method for the smaller rounds and squares and diamond-square for the larger sizes.

The south end of the merchant mill building offers space for chipping, grinding and inspection. An upcut shear and leveler, and a straightener for flats are installed here. Just outside of the building is a pickling unit consisting of one acid tank and one rinse tank, each

MERCHANT MILL DATA

Stand	Nominal size, in.	Distance from preceding stand, ft	Roll working diameter, in.		Roll body length, in.	Hp of driving motor	Speed of drive motor, rpm	Gear ratio	Roll speed, rpm	Rolling speed, fpm†
			Maximum	Minimum						
No. 1 vertical edger			22	20.5	9¼	100	300-900	42.0	7.16-21.5	41.4-115
No. 1 stand	21	10	19.5	17.75	40	300	150-300	12.6	11.9-23.8	60.8-111
No. 2 stand	21	28	20.5	18.75	40	400	200-400	12.6	15.9-31.8	85.8-156
No. 3 stand	21	38	20.37	18.63	40	500	150-400	10.5	14.3-38.1	76.5-186
No. 4 stand	21	14	20.5	18.75	40	500	150-400	7.59	19.8-52.8	106.5-259
No. 2 vertical edger		10	19	17	4	100	485-1200	18.5	26.2-64.8	131-290
No. 5 stand	18	8	18.13	16.5	36	600	300-600	7.59	39.6-79.2	188-342
No. 6 stand	18	14	18.13	16.5	36	600	300-600	5.54	54.1-108.2	256-468
No. 7 stand	18	10	18.3	16.67	36	700	300-750	5.54	54.1-135.2	259-591
No. 8 stand	18	10	18.3	16.67	36	700	300-750	4.38	68.6-171.4	329-750
No. 9 stand	18	152	18.3	16.67	36	1000	200-600	3.03	66-198	317-865
No. 10 stand	18	*	18.3	16.67	36				66-198	317-865
No. 11 stand	18	140	18.5	16.87	36			3.54	66.4-186.5	322-825
No. 12 stand	18	*	18.5	16.87	36	1425	235-600		66.4-186.5	322-825
No. 13 stand	14	*	14.5	13	25			2.335	101-283	386-965
No. 14 stand	14	*	14.5	13	25	500	125-375	Direct	125-375	475-1278
No. 15 stand	10	*	10.3	9.3	17	500	300-750	1.03	292-730	775-1750
No. 16 stand	10	*	10.3	9.3	17			.829	362-906	975-2200

*This stand not in tandem line with preceding stand.
†Minimum fpm calculated from minimum rpm and maximum working diameter of new roll. Maximum fpm calculated from maximum rpm and minimum working diameter of roll.

45 ft long x 6 ft wide x 5 ft deep. The pickling tank is heated by a submerged gas burner and suction fans gather the acid fumes which are washed in a scrubber. Waste acid is neutralized in an acid disposal plant. The merchant mill building, which is 113 ft 8 in. wide x 1250 ft long, butts against the shipping yard previously mentioned in connection with the structural mill, and is served by two 15 ton cranes.

Each main drive motor is indirectly compounded through its own individual series exciter so as to obtain flat speed regulation over the entire speed range.

The power supply for these motors is a 2500 kw, 6 phase rectifier, the first installation of this type in the country. Taps on the rectifier transformer (located in a pit under the mill itself, immediately adjacent to the rectifier) permit operating continuously down to 70 per cent voltage, should it be desired to lower the speed of the entire mill below that corresponding to rated voltage. These primary taps correspond to approximately 420, 480, 540 and 600 volts d-c output.

Rectifier output voltage may be regulated from zero to full by means of ignition control. The entire mill (or the section desired) is started together by connecting the motors to the rectifier at zero voltage, and then raising the voltage by means of a motor driven phase shifter which shifts the firing point of the rectifier tubes. Ignition control is also used to automatically regulate for constant bus voltage during operation and to correct for the slightly drooping voltage regulation of the rectifier and for variations in a-c power supply.

Since a rectifier cannot feed power back into the line, regenerative braking cannot be used. Therefore emergency stops are accomplished by disconnecting the motors from the bus and using dynamic braking.

The drive motors, having an enclosing bell on the front end for ventilation from a down-draft recirculating cooling system, are located in a motor room 310 ft long running along the mill. Here are also located the exciter sets and control boards for the mill drives, as well as seven motor-generator sets which supply variable frequency power to the individually motor driven table rollers previously mentioned.

A 1000 kw mercury arc rectifier unit is located in a control house in the runout end of the mill building. It is connected to the 250 volt d-c distribution system which supplies power for auxiliary motors in the structural and merchant mills and alloy finishing department.

Adjacent to the merchant mill building is another bay 100 ft wide x 650 ft long devoted to finishing equipment. Included here are four car-type annealing furnaces 28 ft long x 10 ft wide, fired with coke oven gas and provided with means for recirculation of waste gases. An oil and water quench tank with circulating system is located here, and a gantry crane serves the heat treating area. One pickling tank, with rinse tank, duplicates of those located in the west billet yard, is also provided here. Bar straighteners, benders and saws are also installed in this department.

Wire finishing facilities include an acid tank, sull rack, lime vats and a flash baker for treatment of the rods before drawing, a five-block wire drawing frame, and a cylindrical portable annealing cover with three bases. An atmosphere generator supplies protective atmosphere for this annealing unit.

The previously mentioned facilities for 8 in. shell production are also located here.

PLANT SERVICES

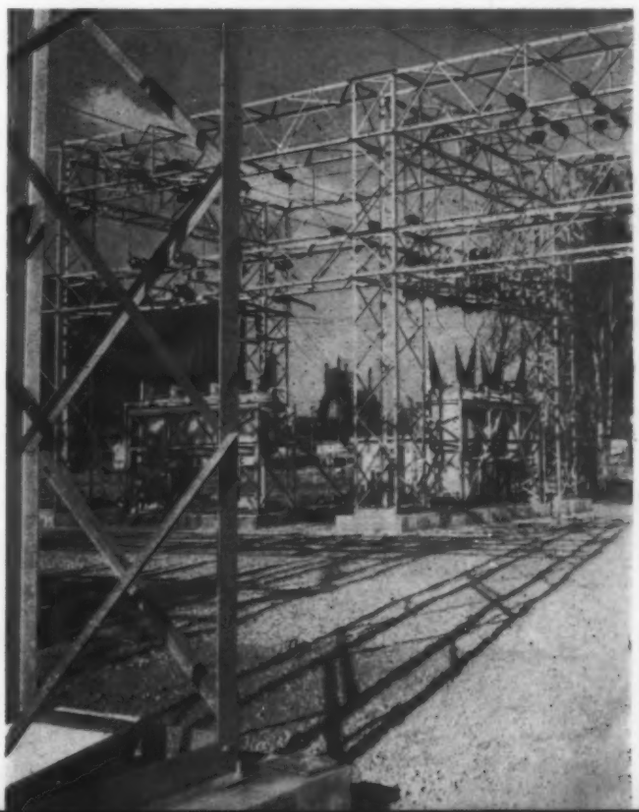
All electric power for the plant is purchased from the utility company serving the district. Two main lines, 67,000 volt, 3 phase, 50 cycles, come into the plant from the opposite ends of a transmission loop, minimizing the chance of service interruptions. Both lines enter a substation owned by the steel company and containing two banks of three single-phase 3333 kva transformers each, and two three-phase 5000 kva transformers, all 67,000/6900 volts. Fan cooling which has been provided for these units permits up to 30 per cent overload.

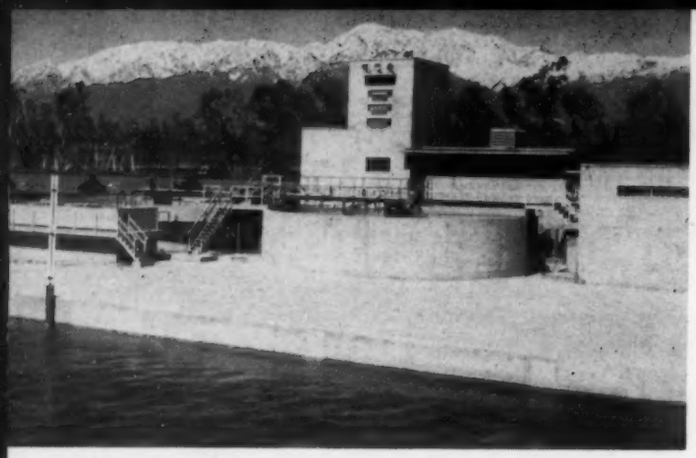
All power then goes over two lines to the plate mill motor-room, which is the central distribution point for the entire plant, and then on to other load centers. Dual circuits are installed on all vital equipment, and feeders are worked at full capacity. Their sizes were determined from allowable temperatures in order to save critical materials.

Underground conductor tunnels of concrete construction are widely used, and in some cases are ventilated to hold down temperature and thus further minimize copper use. At the plate mill motor-room, 25,000 cfm of filtered air is blown into the tunnel system, and leaves through slots into various control houses. Distribution of power through the plant is principally at 6900 volts, with step-down transformers to 2300 and 460 volts where needed.

Direct-current is provided for mill auxiliaries from an interconnected system containing two 1000 kw motor-

Main incoming substation through which electric power enters the steel plant. Transformers reduce 67,000 transmission voltage to 6900 distribution voltage.





Water treatment plant, with clariflocculators in center, pumping station in rear and settling basin in foreground.

generator sets in the plate mill, one 1500 kw rectifier in the 29 in. mill motor-room, one 1000 kw rectifier in the lower end of the structural mill building, and one 1000 kw rectifier at the merchant mill. This system is controlled from the 36 in. mill motor-room, the load on the rectifiers being adjusted through remotely controlled rheostats which regulate the rectifier voltages.

Two 1000 kw motor-generator sets at the powerhouse provide d-c where it is required in that area, and small isolated motor generator sets (purchased second hand) are installed at the sinter plant, skull cracker, stripper building and foundry for d-c supply.

All water for the entire plant is purchased from the company serving the locality and water conservation has therefore been carried to a high degree. Two separate water systems were installed, one for industrial use and one for "domestic" use. Both are completely closed systems. Waste water from the domestic system passes through a sewage treating plant, and the effluent flows into the industrial system. All water used on plant equipment is reclaimed and reused, with the exception of that used for quenching coke and for cooling sprays on the pig machine. Thus, makeup to the entire system only amounts to about 5 per cent of the 50,000 gpm average circulation. Seven cooling towers installed at strategic spots cool the water before it is recirculated through the system. One tower, of 12,000 gpm capacity, is used for water from the blowers and condensers in the powerhouse; two towers, 15,200 gpm, for water used in cooling in the blast furnace, open hearth and coke plant; two towers, 16,600 gpm, for water used in mill service, etc.; one tower, 3000 gpm, for cooling water from the gas washer; and one tower serves certain units in the by-product plant.

Two wells on the property are available for emergency use and a 14 ft aqueduct running through the property affords standby protection.

Steam demands of the plant are supplied from two producing centers. The powerhouse contains three boilers rated at 120,000 lb per hr of steam at 450 psi, 725 F total temperature. They are fired primarily with blast furnace gas, with standby facilities for coke oven gas and fuel oil, and are equipped with full automatic control. Steam from this source is used in the turboblowers, coke plant, etc. It is planned to install turbogenerator equipment here when conditions permit. The other steam generating installation consists of the two waste heat boilers previously mentioned.

Maintenance shops include the usual machine, locomotive, forge, welding, pipe, boiler and electric shops, as well as a large pattern shop and foundry equipped either for pouring direct metal or for cupola operation. Oxygen is piped around the plant from a central station which is charged with liquid oxygen.

Approximately 35 miles of railroad tracks are installed and all switching is done by diesel-electric locomotives, seven of 80 ton size and one of 45 tons. Practically all vehicular roads throughout the plant are paved.

Offices, locker rooms, hospital, cafeteria, laboratory, etc. are of modernistic architecture and are well landscaped. Rows of eucalyptus trees, planted to serve as windbreaks, also contribute to the appearance of the plant.

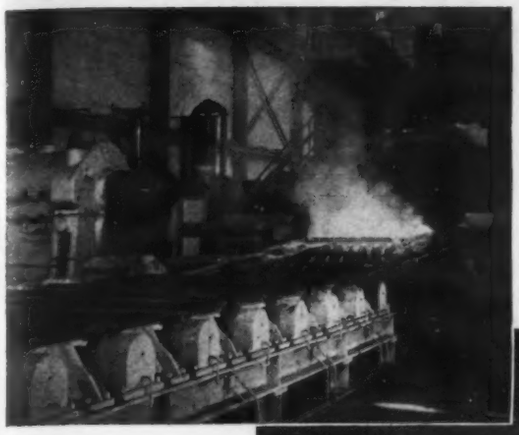
CONCLUSION

As might be noted, the plant at present lacks some of the equipment which it should have to make it a complete unit capable of operating at maximum efficiency. Such equipment, however, is covered in plans for the future and will be added as soon as possible. Also under consideration are tube mills and wide hot and cold strip mills, with complete finishing equipment for sheets and tinplate, additions needed in order to turn out classes of products widely used in west coast industries.

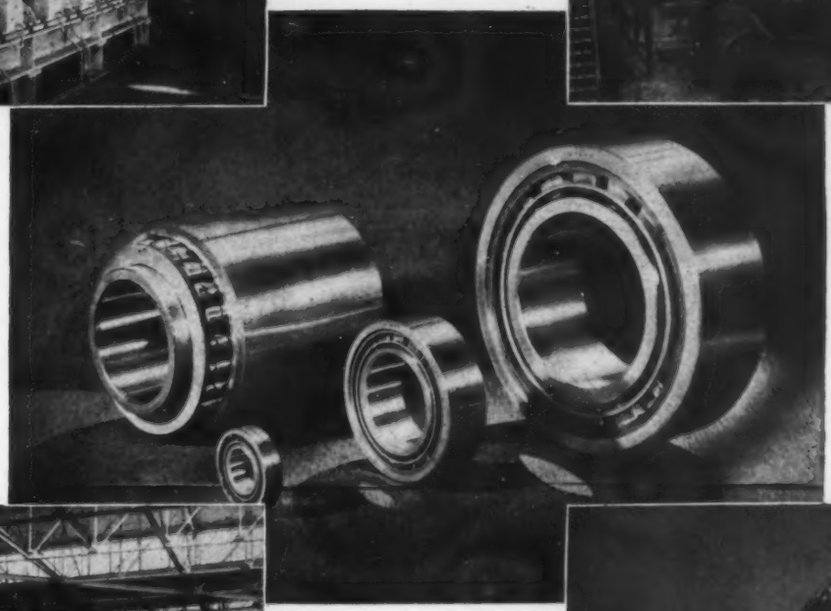
There has been much speculation as to the future outlook for Fontana. There is little doubt that the steel consumption of the western states can absorb the output of this plant as well as that of the other western plants. Fontana is fortunately located close to the largest industrial center on the west coast — a center using about 40 per cent of western steel consumption.

In the postwar period, however, the long rail hauls required to assemble the raw materials at Fontana promise to be a formidable item in the economy of operation. At the present time, this plant enjoys a price margin of $20.50 per ton of plates over eastern and midwestern plants. It is expected that, with the return of peacetime conditions, production costs will be materially lower than at present; whether the economy of operation can then meet open competition from eastern plants is a moot question which only the future can decide.

The plant foundry, equipped for pouring direct metal and for cupola operation, can produce ingot molds as well as other plant castings.



Opposite and below, some of the Kaiser equipment which HYATT serves.



Above, some of the sizes and types of HYATT wound and solid roller bearings used in the Kaiser Company Steel Plant at Fontana, California.

AT FONTANA TOO — BEARINGS: *HYATT*

• Serving the steel industry over several decades, you would naturally expect to find Hyatt Roller Bearings in the newest of mills. Wherever suited for the application Hyatt Roller Bearings were generously used throughout the Kaiser Steel Mill, near Fontana. Again proving that Hyatts are ideal for heavy steel mill service. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.

HYATT ROLLER BEARINGS

...OFF

LEFT UPPER:
Table Drives

LEFT BELOW:
110" Lewis Plate Mil

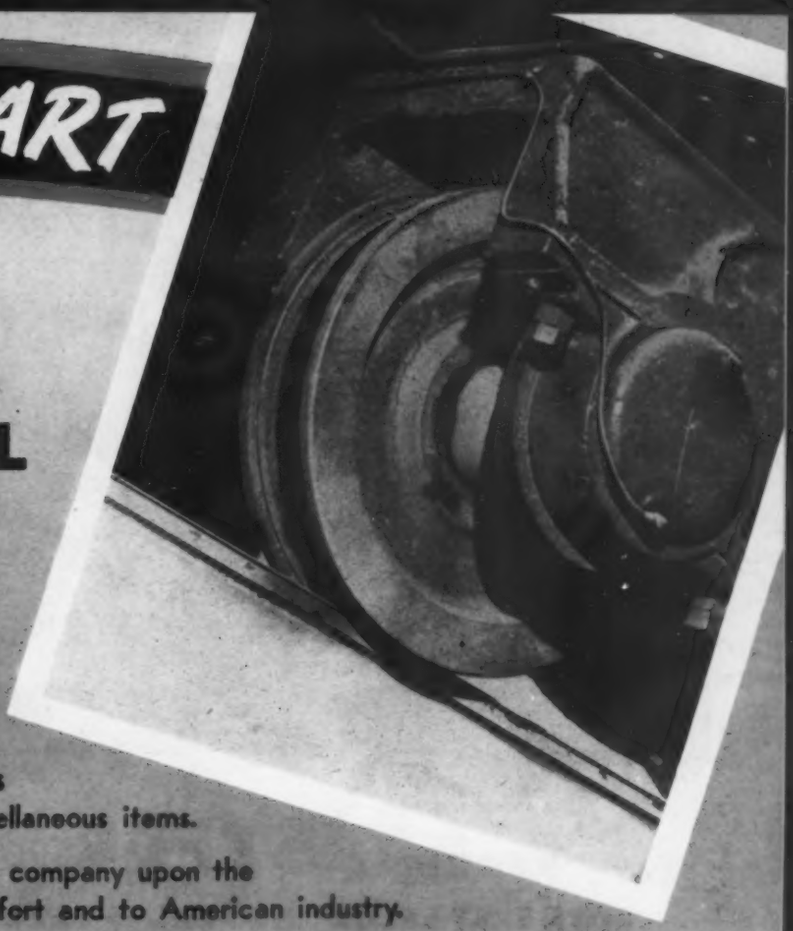
TO A FINE START

THE NEW

FONTANA, CAL.
KAISER STEEL MILL

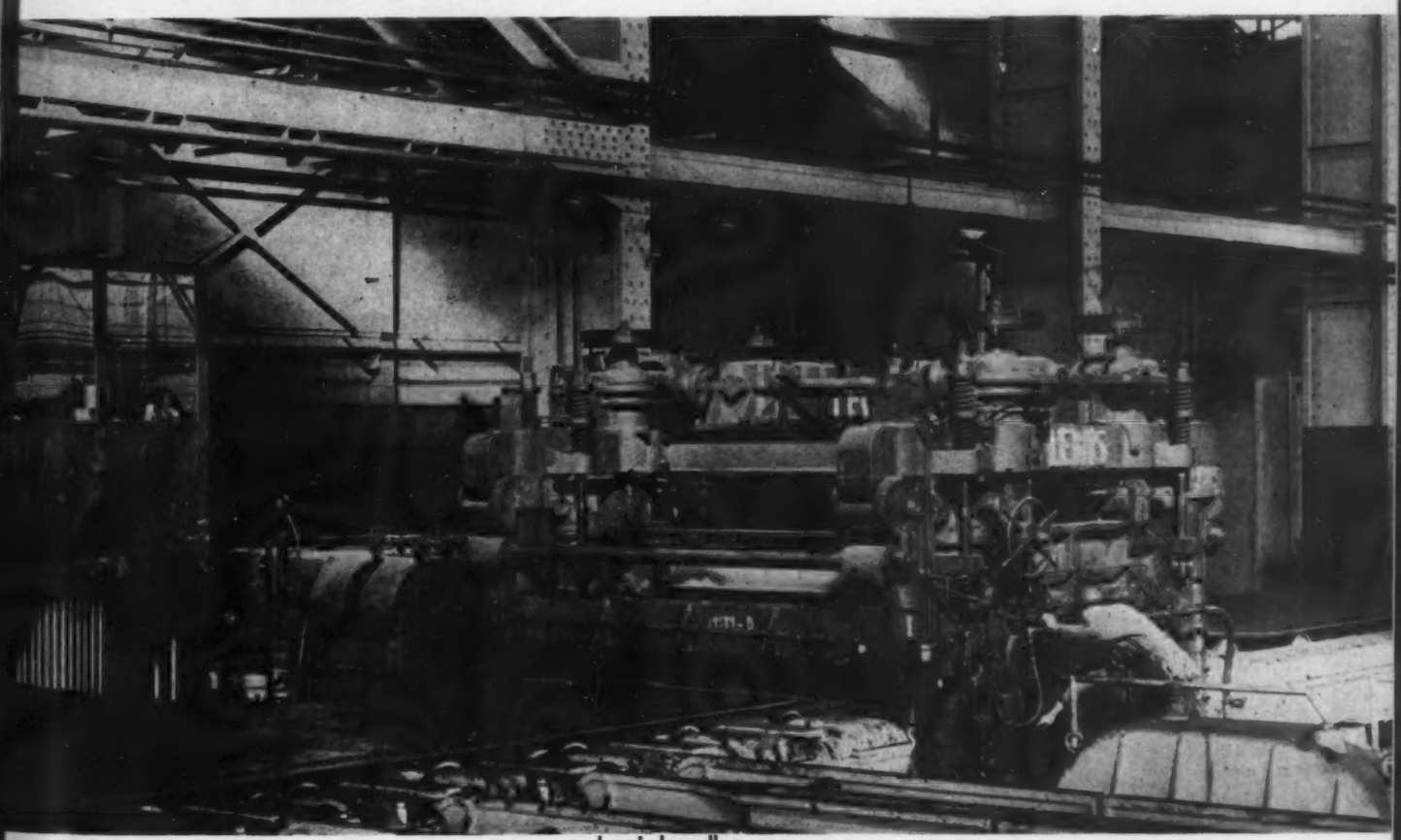
Is Equipped With A Large Number Of

"TOOL STEEL" PROCESS



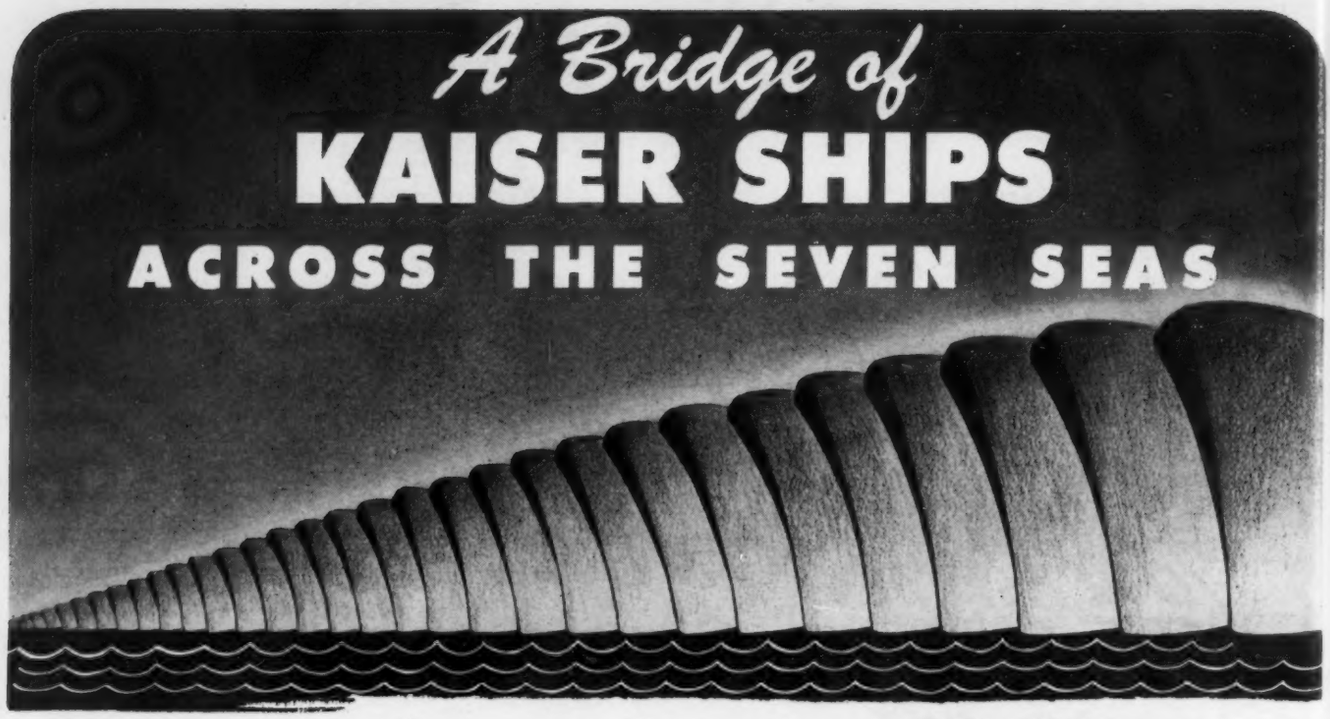
allations include "TOOL STEEL" Table
aring — Leveller Rolls — Side Guard Rolls
Crane Wheels and Gearing and other miscellaneous items.

Tool Steel Gear & Pinion Co. congratulates the company upon the
nching of such a valuable addition to the war effort and to American industry.



Lewis Leveller

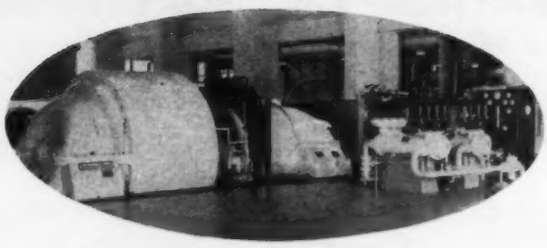
THE TOOL STEEL GEAR & PINION CO.
CINCINNATI 16, OHIO



REQUIRES STEEL
MORE STEEL . . . BETTER STEEL
IN LESS TIME

The world marveled at the Kaiser technique . . . here was a man who departed from the conventional . . . and got things done . . . ships, more ships, better ships, and in less time.

Perhaps it is with a touch of pride that we refer to the time when the Kaiser Steel Plant was constructed at Fontana . . . Askania Automatic Control was chosen! By past performance records throughout the steel industry Askania Control was the logical choice because here, indeed, was a tool which helped the Kaiser project produce more steel . . . better steel . . . in less time!



ASKANIA
Automatic Control

The above photo shows the I-R Turbo Blower installation at the Kaiser Fontana plant.

Askania Control is also used for Control of Pressure . . . Flow and Ratio on:

BLAST FURNACES
STOVE BURNER . . . GAS BLEEDER
COKE OVENS
STACK DRAFT . . . COLLECTER MAINS
OVEN FUEL GAS . . . GAS EXHAUSTERS
BOILERS
MULTI-FUEL COMBUSTION CONTROL
(Oil . . . B.F. Gas . . . C.O. Gas)
SOAKING PITS
OPEN HEARTH FURNACES
STRUCTURAL MILL
HEATING FURNACES
ANNEALING FURNACES

ASKANIA REGULATOR CO.
A GENERAL PRECISION EQUIPMENT CORPORATION SUBSIDIARY
1601 S. MICHIGAN AVENUE, CHICAGO 16, ILLINOIS

THE ROBINS-MESSITER ORE BEDDING AND RECLAIMING SYSTEM

at the Fontana Plant of Kaiser Company, Inc.

AT the Kaiser plant in Fontana, some 700,000 tons of steel ingots are produced a year. That means pretty steady production for the blast furnace — least possible time out for changes of burden. And to attain this end, the physical and chemical characteristics of the ores must be as uniform as possible.

To maintain that uniformity is the function — and the achievement — of the Robins-Messiter Ore Bedding and Reclaiming System.

This System was incorporated into the huge Kaiser plant because of its demonstrated ability to take ores of various characteristics and blend them into blast furnace burdens possessing qualities that are constant and uniform.

Before deciding upon the installation, the Kaiser engineers investigated the performance record of the Robins-Messiter System. They were shown one instance where ores from 13 different mines, each with its own chemical content, were blended so perfectly that as long as five weeks went by without having to touch the furnace burden — whereas, before the System was installed, several changes a day were necessary. What is more, output was increased 9%, coke consumption was reduced 300 lbs. per ton and flue dust loss was reduced 37½%.

Naturally, we are proud to have the Robins-Messiter Ore Bedding and Reclaiming System in the Kaiser plant at Fontana. It is also performing with equal satisfaction for two other plants in the Western area. Perhaps it could help you to increase production, improve quality, effect economies. If you wish, full particulars will be placed before you without cost or obligation. When writing for them, please address Dept. ISE-4.

ENGINEERS, MANUFACTURERS AND ERECTORS OF MATERIALS HANDLING MACHINERY

ROBINS *makes:* BELT CONVEYORS · COAL AND ORE BRIDGES · BUCKET ELEVATORS · CAR AND BARGE HAULS · CAR DUMPERS · CAR RETARDERS · CASTINGS · CHUTES · CONVEYOR IDLERS AND PULLEYS · CRUSHERS · FEEDERS · FOUNDRY SHAKEOUTS · GATES · GEARS · GRAB BUCKETS · PIVOTED BUCKET CONVEYORS · VIBRATING SCREENS · SCREEN CLOTH · SELF-UNLOADING BOAT MECHANISMS · SKIP HOISTS · STORAGE AND RECLAIMING MACHINES AND SYSTEMS · TAKEUPS · LOADING AND UNLOADING TOWERS · TRIPPERS · WEIGH LARRIES · WINCHES · WINDLASSES

ROBINS
CONVEYORS
INCORPORATED
Founded in 1906 as Robins Conveying Belt Co.
PASSAIC • NEW JERSEY

FOR MATERIAL AID IN MATERIALS HANDLING . . . . . . **It's ROBINS**

CONVERTERS, MIXERS
TILTING OPEN HEARTH FURNACES
DUPLEX STEEL PLANTS

600-ton Mixer

25-ton Converter

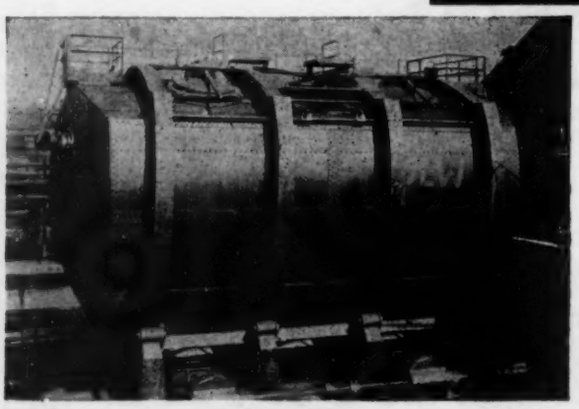
These pictures give but small evidence of Pennsylvania Engineering Works' contribution to the Steel Industry.

Backed by many years of experience and the great number of installations in the many Steel Plants, the Pennsylvania Engineering Works is prepared to design, fabricate and erect complete Duplex Plants, including Mixers —25 tons to 2000 tons capacity, Open Hearth Furnaces—50 tons to 400 tons capacity—both tilting and stationary, Coverters—5 to 50 tons capacity, Converter Jack Cars, Bottom Oven Cars, Regulating Valves, Slag Cars, Ladles, Ladle Cars, Transfer Cars, Jib Cranes and Hauling Systems.

Blowing Charge in 15-ton Converter

Installations of some of the illustrated equipment at

Inland Steel Company
Tennessee Coal, Iron & Railroad Co.
Youngstown Sheet & Tube Company
Carnegie-Illinois Steel Corporation
Republic Steel Corporation
Bethlehem Steel Company
American Steel & Wire Company
Weirton Steel Company
Jones & Laughlin Steel Corporation
Broken Hill Proprietary Co., Australia
Tata Iron & Steel Company, India
Algoma Steel Company, Canada
Steel Company of Canada, Ltd.
Siderurgica del Mediterraneo, Spain
Cia Fundidora de Fierro y Acero, Mexico
Ford Motor Co., Detroit and England
Kaiser Company
Columbia Steel Company
Copperweld Steel Company
Great Lakes Steel Company
American Rolling Mill Company
National Tube Company
Russian Soviet Union



1500-ton Mixer

400-ton Tilting Open Hearth Furnace

Pennsylvania Engineering Works
New Castle, Penna.

Straightening Machines

at

KAISER Co., Inc. and other plants throughout the U.S.A.

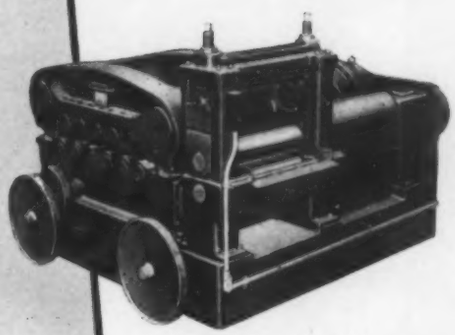
No. 2B 24-Roll Combination Horizontal & Vertical Straightener

No. 3AH 9-roll Horizontal Straightener

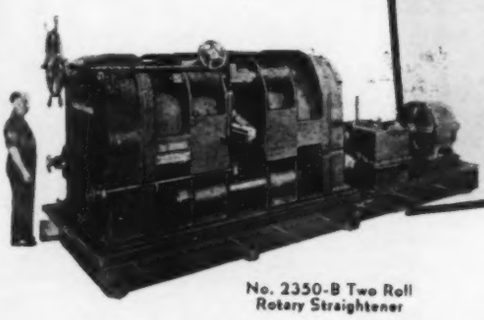
MANUFACTURERS OF:

Straightening Rolls - Bending Rolls - Cold Roll Forming Machines - Gang Slitters - Edging Machines - Special Metal Working Equipment

No. 9VS Two Pass Straightener



No. 7 13-roll Leveller



No. 2350-B Two Roll Rotary Straightener

No. 5400-B Five Roll Rotary Straightener

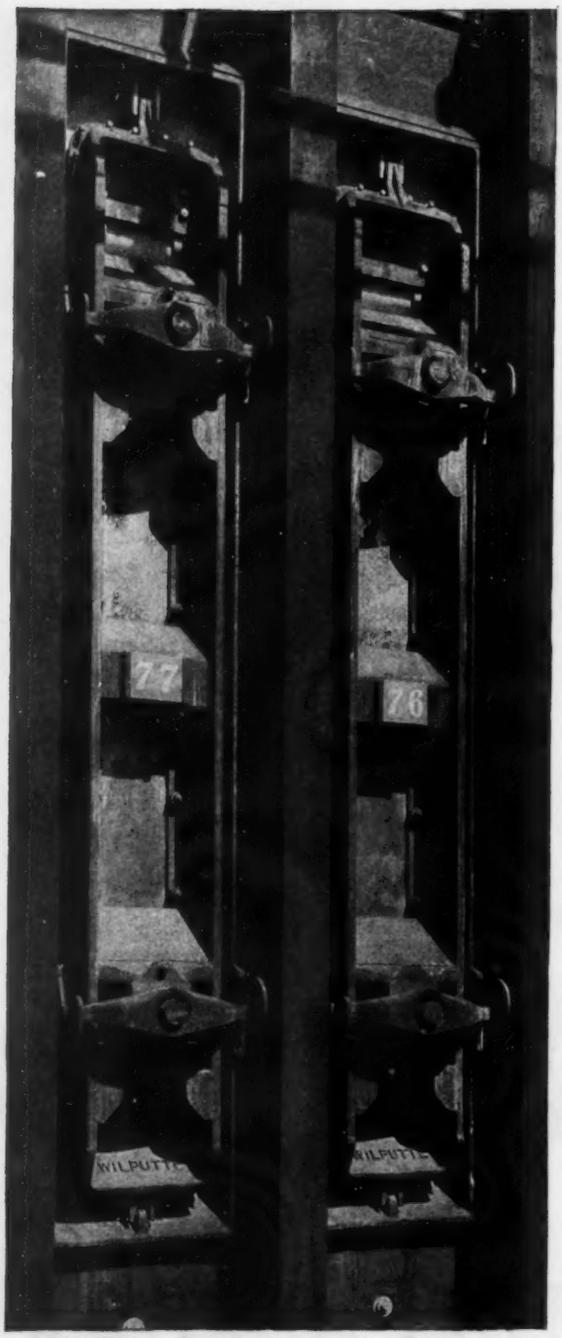
KANE & ROACH

INCORPORATED

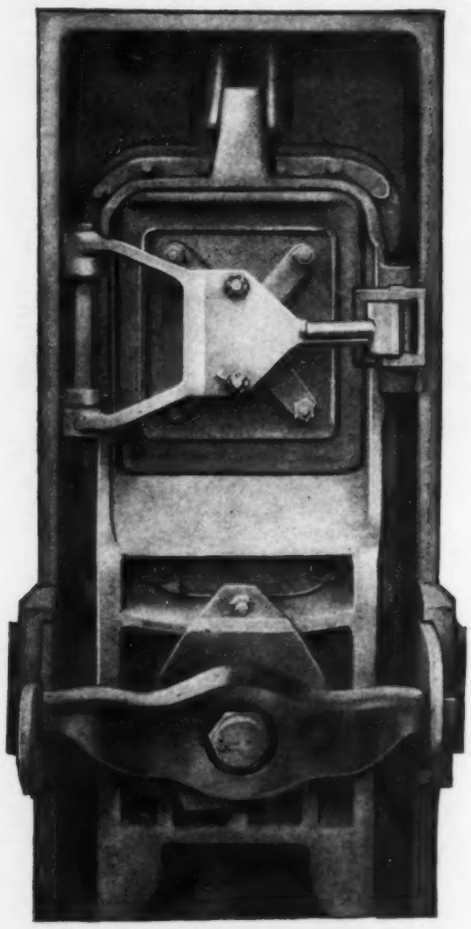
Syracuse, New York

Established 1887

WILPUTTE
Still Leads



OVEN DOORS
AND
LEVELER DOORS



BOTH
SELF-SEALING AND TIGHT TOO!

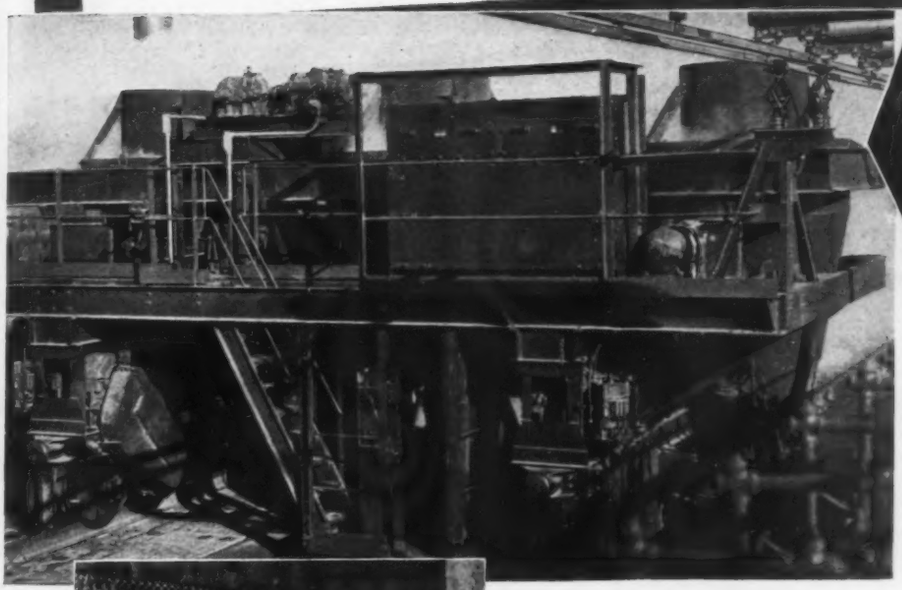
WILPUTTE COKE OVEN CORPORATION

A SUBSIDIARY OF SEMET-SOLVAY COMPANY

40 RECTOR STREET — NEW YORK 6, N.Y.

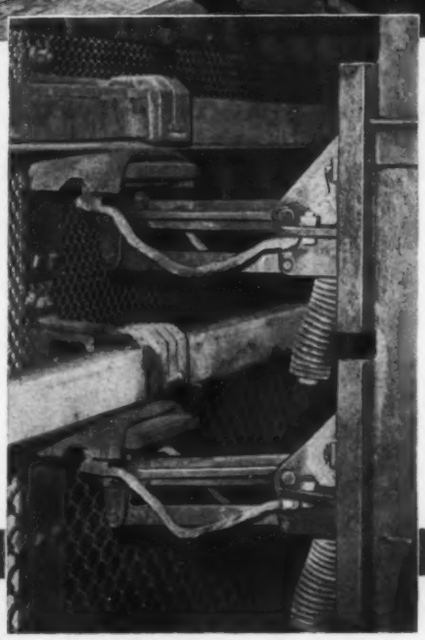
TRAVELLING ELECTRICAL CONTACT

at Fontana



◀ Larry Car over Koppers Becker-Type Coke ovens at the Kaiser Steel Plant.

▲ Keystone Pantagraph Collectors



▲ Keystone Contact Rail Shoes on coke pusher.

THE numerous installations of Keystone Contact Rail Material in the new Kaiser Steel Plant will provide steady, unfailing electric power to many vital operations. We are proud to have had the opportunity to contribute to this extensive undertaking.

ELECTRIC SERVICE MANUFACTURING CO.

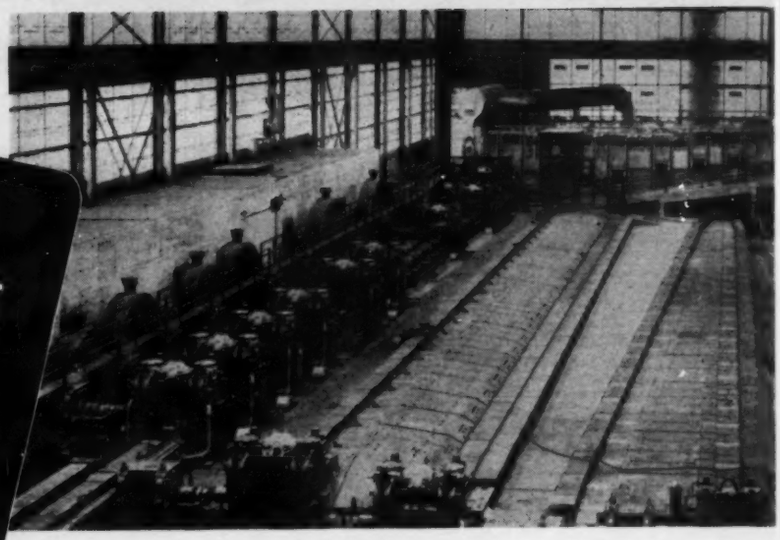
17th & Cambria Sts., Phila. 32, Pa., 111 N. Canal St., Chicago 6, Ill.

Branches in principal cities

KEYSTONE

Contact Rail Material

The KAISER STEEL PLANT USES MANY Timken Bearings



21", 18" and 14" mill stands with runout and transfer tables.

Manipulator drive on 56" mill.

★ Timken Bearings also are used in several other pieces of equipment including furnace pusher, ingot buggy and roll lathes.

Manufacturers and users of steel mill machinery know it pays to have Timken Bearings in their equipment. See that the trade-mark "TIMKEN" appears on every bearing you use.

THE TIMKEN ROLLER BEARING COMPANY, CANTON 6, OHIO

Timken Tapered Roller Bearings are used in the following equipment installed at the Kaiser steel plant, Fontana, California.

EQUIPMENT	BEARING LOCATIONS
21″ Mill	Roll Necks, Pinion Stands, Gear Drive
18″ Mill	Roll Necks, Pinion Stands, Gear Drive
14″ Mill	Pinion Stand, Gear Drive
10″ Mill	Pinion Stand, Gear Drive
Approach Table	Table Rolls, Drive Shaft, Live Shaft
Transfer Table	Runout Roll, Drive, Chain Drive
Edger	Drive
Rotary Flying Crop Shear	Pinion Shaft, Knife Shaft

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

MOULDS VALLEY STOOLS

VALLEY MOULD & IRON CORP.

General Offices: HUBBARD, OHIO

Western Office: Chicago, Ill.

Northern Office: Cleveland, O.

A SINGLE OBJECTIVE.....

Production Control

A SINGLE RESPONSIBILITY IN ACHIEVING IT

Higher tonnage and uniform quality of product result from efficient control of steel mill equipment. An invaluable aid in achieving this is a system of automatic controls and instruments that allows operators to concentrate on the factors making for optimum production. To secure these results, Republic Flow Meters Co. offers a complete manufacturing and engineering service—a single responsibility—in the field of measurement and control. We will gladly co-operate with you in the solution of any metering or control problem. Your inquiries involve no obligation.

FURNACE CONTROLS
For furnace pressure, fuel, fuel-air ratio.

BOILER CONTROLS
For all boilers, all types of firing.

REGULATORS
For pressure, flow, speed, level, ratio.

GAS MIXER CONTROLS
For mixing gases in desired ratio.

COKE OVEN GAS CONTROLS
For collecting mains, stack draft, pressures.

RING-BALANCE METERS
For steam, water, gas, air, oil, etc.

ELECTRICAL FLOW METERS
For steam, water, gas, air, oil, etc.

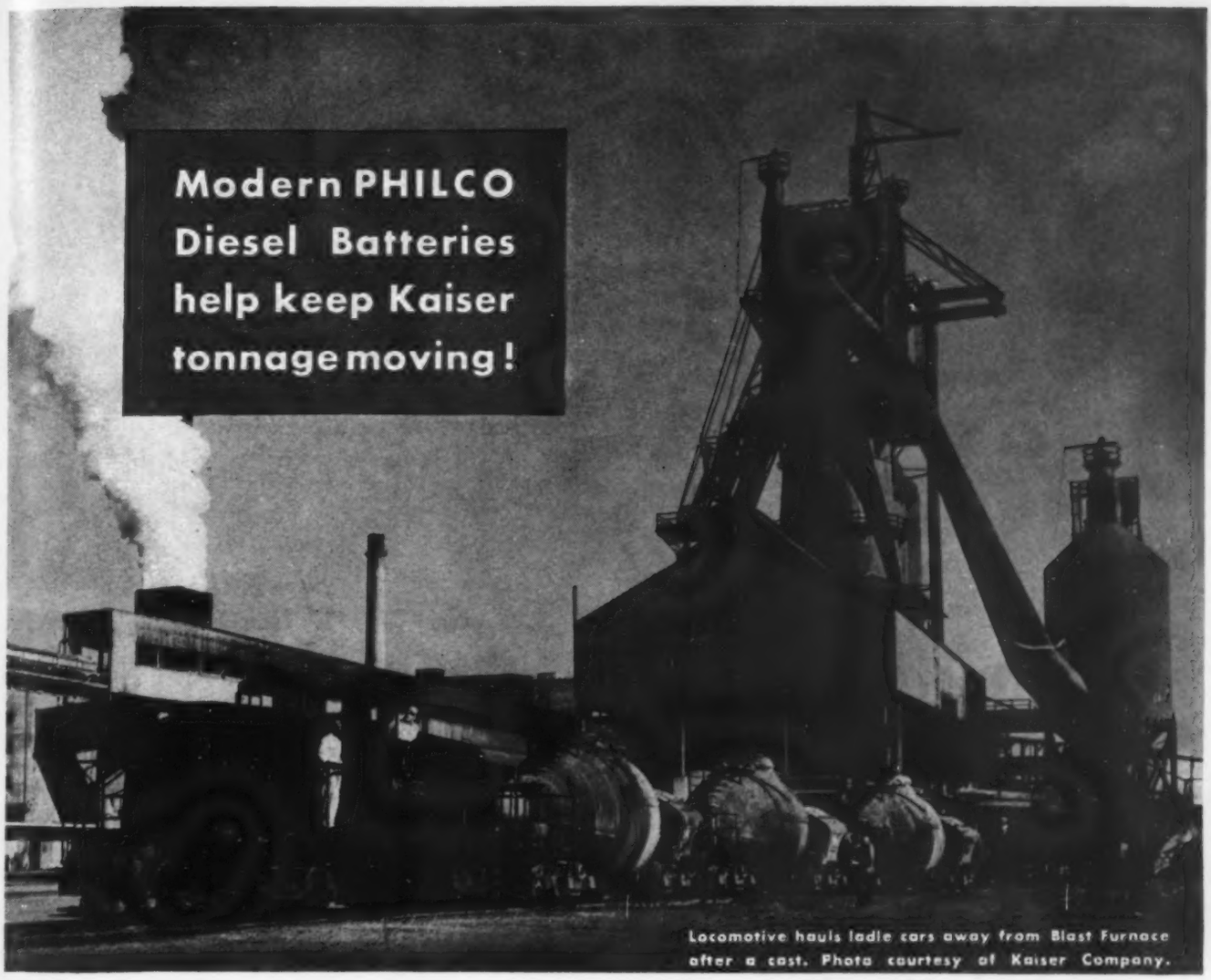
FURNACE PRESSURE RECORDERS
For pressure in all types of furnaces.

DRAFT & PRESSURE INDICATORS
For draft, pressure, flow, temperature, CO_2, etc.

THERMOMETERS
For temperatures up to 1000 F.

DATA BOOKS MAILED ON REQUEST

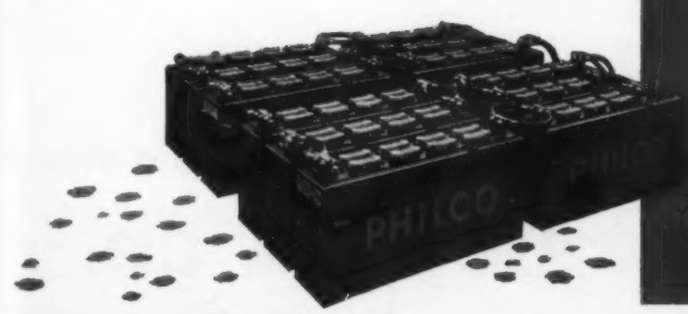
REPUBLIC FLOW METERS CO.
2220 Diversey Parkway, Chicago, Illinois



Locomotive hauls ladle cars away from Blast Furnace after a cast. Photo courtesy of Kaiser Company.

AT KAISER STEEL WORKS, Fontana, California, Philco diesel starting batteries provide dependable starting power for a fleet of 80-Ton G.E. diesel electric switching locomotives. The great advantage of a Philco in such service is its thorough dependability—its extra wallop that always starts a diesel engine immediately. Important, too, are the extra quality features in a Philco, which have widely demonstrated their longer life and lower cost. New Philco Battery catalogs for all services are now available. Write today. PHILCO CORPORATION, Storage Battery Division, Trenton 7, New Jersey. *Makers of the famous Philco "Thirty".*

Typical 56-cell Philco Diesel Starting Battery



SPECIFY

PHILCO

STORAGE BATTERIES

FOR 50 YEARS A LEADER IN INDUSTRIAL STORAGE BATTERY DEVELOPMENT

55-8 pancake coil OHIO MAGNET at Fontana, California Plant of Kaiser Co., Inc.

OHIO

EXTRA STRENGTH

Magnets

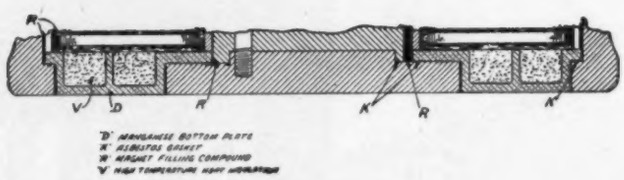
The OHIO 6 pancake coil magnets in the 55" and 65" diameter will average 35% better lifts than the standard magnets.

The OHIO 8 pancake coil magnets will average 75% more than the standard magnets.

Labor cost per ton and time required to handle are both reduced correspondingly.

Purchase of OHIO Extra Strength magnets have several times obviated the necessity of installing an additional crane.

★ When OHIO magnets are required to lift hot materials the heat resisting bottom construction shows below successfully retards the flow of heat from the load to the magnet coil and permits all day use.



Have you a problem requiring fast lifting or lifting of hot steel?

THE OHIO ELECTRIC MFG. CO.

5907 BELLFORD AVENUE **CLEVELAND 4, OHIO**

Where STRENGTH is the Prime Requirement

BUY WAR BONDS

BIRDSBORO 30 ROLLS

The strongest and toughest of Alloy Steel Rolls.

This Roll used for blooming, cogging and roughing
- Aircraft Quality Steel—(High Percentage Alloy Type.)
- Stainless Steel—(High Percentage Alloy Type.)
- High Speed Steel.

And all rollable steel very difficult to reduce because of density.

Consult our Roll Engineers if you are experiencing difficulty with Rolling Ingots and Billets of the above steels.

Ask for our Roll Schedules showing applications for Birdsboro Rolls.

BIRDSBORO STEEL FOUNDRY & MACHINE COMPANY • BIRDSBORO, PENNSYLVANIA

BIRDSBORO
STEEL MILL EQUIPMENT

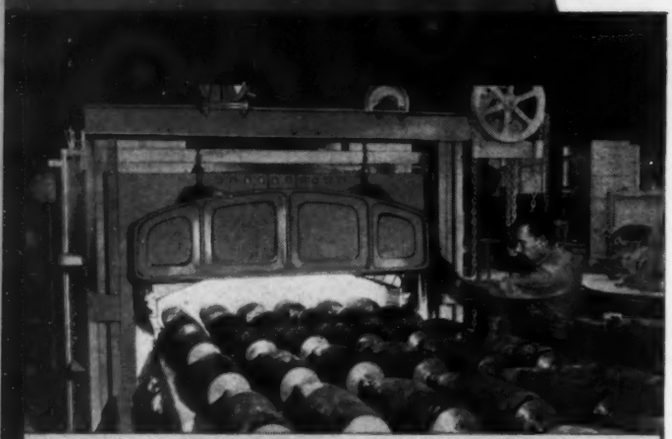
HEATING CAPACITY.. BIG TONNAGE

"Surface" Furnaces Deliver "HOT" Goods for Essential Materials

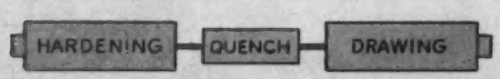
● In the great Kaiser Company, Inc. Steel Plant at Fontana, California and the adjoining Army Ordnance Plant built and operated by Kaiser Industries, "Surface" furnaces are operating in an "all-out" effort to supply essential materials to our fighting men. From the heating of billets and plates to the heat treating of large shells, "Surface" has provided modern equipment to produce unusually large heating capacity to meet BIG TONNAGE demands.

Each unit is equipped with "Surface" advanced developments including automatic controls for all heating cycles. "Surface" furnace design and construction is well known in the steel industry and with many years experience in economical fuel utilization, a low-cost-per-ton operation is assured.

Wherever heat is used—from ingot to the finished product, it pays to consult "Surface" Industrial Furnace Engineers about modern methods and equipment.



Battery of 8 Heat Treating Units, each line consisting of a Walking Beam Hardening Furnace, Automatic Quenching Mechanism, and Walking Beam Draw Furnace. Operation of the heating furnace, quench conveyor, spray equipment, and draw furnaces are synchronized by a timing clock which starts all drives simultaneously at adjusted intervals.



Two 8-inch Shell Heat Treating Units, each line consisting of a Rotary Hearth Hardening Furnace, Quench Tank, and Chain Type Recirculating Air Draw Furnace.

'Surface'

SURFACE COMBUSTION •

Merchant Mill Billet Reheating Furnace—Push-down type having a sloping solid hearth. Unit is thirty-three feet wide (inside brick) by fifty-one feet long effective length. The fuel is coke-oven gas. Furnace is equipped with tile recuperator and automatic temperature, combustion and draft controls. Total load capacity is fifty-six net tons per hour.

One of Two Structural Mill Furnaces—Each furnace is twenty-three feet wide (inside brick) by seventy-nine feet long effective length. The fuel is coke-oven gas. Furnaces have "Triple-fired" burner arrangement. Automatic temperature, combustion and pressure controls operate on all three firing zones. Carborundum tube type recuperator is used. Total load capacity is eighty net tons per hour, each.

TOLEDO 1, OHIO

BRISTOL'S Indicating Pyrometer Model 420 for temperatures up to 3600°F. fills the bill for single or multiple location temperature indications at one post position.

This instrument uses the millivoltmeter method of measuring thermocouple electromotive force in terms of temperature. An automatic cold-end compensator is built in, to make a single, rugged instrument requiring no routine care or maintenance whatever.

Used in conjunction with one or more of Bristol's 12-Point Rotary Switches, connected in multiple installations, the Model 420 Indicating Pyrometer makes instantly available the temperature at any one of a number of different points in ovens or furnaces.

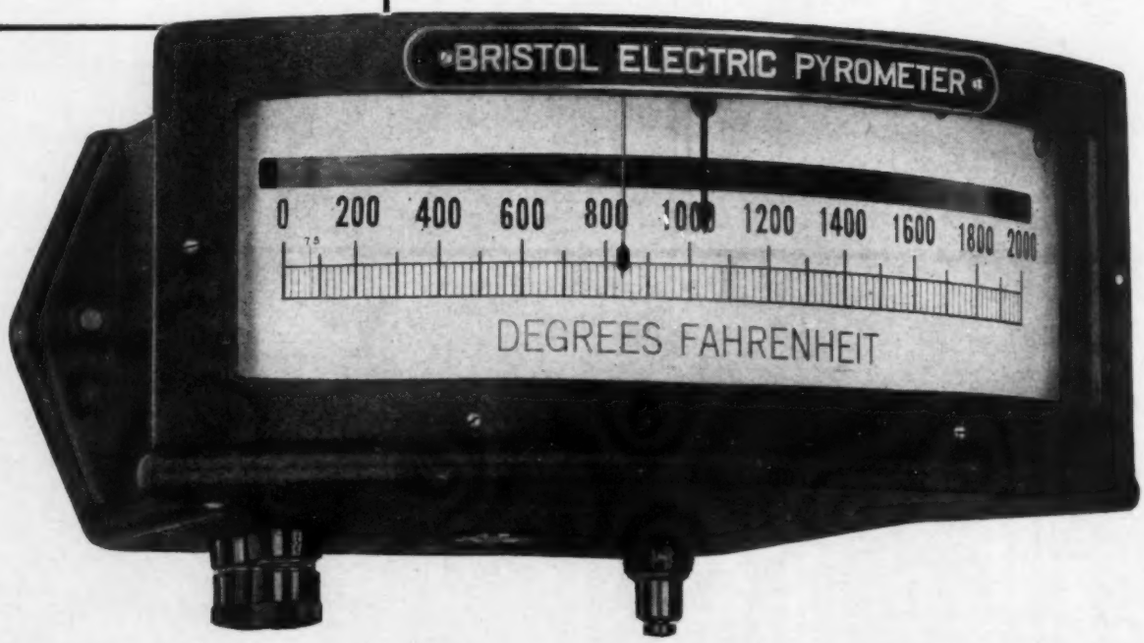
You will want the complete story of the Model 420 Indicating Pyrometer as given in Bulletin 1213. Thermocouples, Protection Wells and Lead Wires for use with it are covered in Bulletin 1211, and if you plan to use it as a Radiation Pyrometer for temperatures up to 3600°F. be sure to ask also for Bulletin 1202.

Address The Bristol Company, 123 Bristol Road, Waterbury 91, Conn. (The Bristol Co. of Canada, Ltd., Toronto, Ontario. Bristol's Instrument Co., Ltd., London, N. W., 10, England.)

TAKE THE 420 IF YOU HAVE TO BE IN 36 PLACES AT ONCE

BRISTOL

... Gives YOU the Most from Heat



AUTOMATIC CONTROLLING AND RECORDING INSTRUMENTS

How Rutland Profits with Bowser EXACT Liquid Control

When a single type of equipment serves a manufacturer in many different ways, that's a definite plus.

Take, for instance, the Bowser Meters in the plant of the Rutland Fire Clay Company, Rutland, Vermont, nationally known makers of heat resisting specialties. First, Bowser Meters measure incoming solvent—an obviously important check-up. Then, they measure—right down to the exact spoonful—the liquids going into Rutland products.

And in both operations, Bowser Meters paid off handsomely in these ways:

Uniformity of Product—Human error is eliminated.

Money-saving—A Bowser Meter on the intake line stopped discrepancies and resulting losses.

Time and Labor Saving—An operator sets the Bowser Predetermining Meter for the amount needed for a mix . . . then goes about other work. Time and Labor is saved! Production steps up!

The Bowser equipment in the Rutland plant was designed to do a special job. So are Bowser Lubricating Systems now standard equipment in more than 90% of American steel mills. Today they are doing an outstanding job in lubricating mill stands, pinion gear sets, reduction gears, turbines, etc. Bowser coolant systems are equally dominant.

The success of Bowser equipment in the steel industry is largely because Bowser installations are engineered to the exact needs of the operation. They become an integral part of the mill. For complete information write to BOWSER, INC., Dept. 13-D, Fort Wayne 2, Indiana.

Not only has Bowser's war production earned the Army-Navy E . . . Bowser equipment has helped earn it for scores of other companies.

BOWSER
SINCE 1885

THE NAME THAT MEANS
EXACT CONTROL OF LIQUIDS

TREADWELL

Aids STEEL in its bid for VICTORY

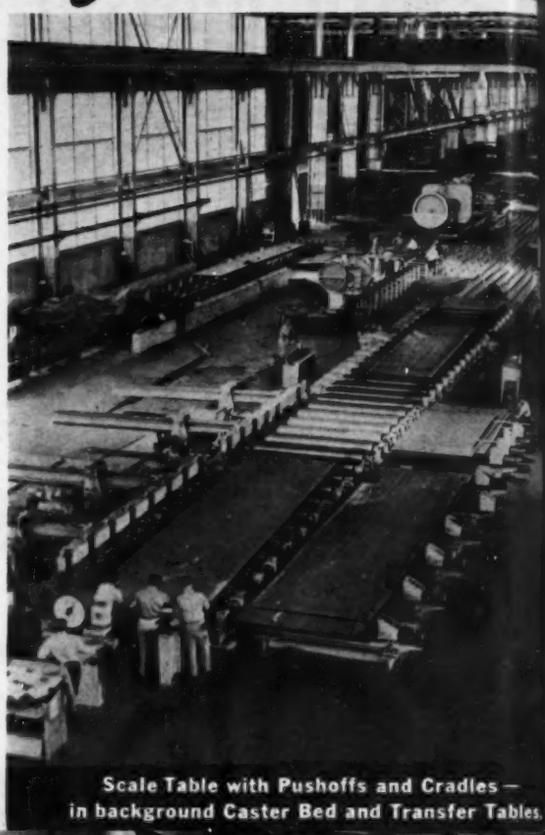
These photographs show illustrations of TREADWELL ROLLING MILL MACHINERY installed at the Kaiser Plate Mill at Fontana, California.

In the building of Rolling Mill Equipment, Treadwell aims toward those principles of design and construction that aids most in assuring the user increased and continuous production at lowest cost.

For over forty years builders of Rolling Mill and Special Machinery.

It will pay you to consult Treadwell for replacements or new units.

The Army-Navy "E" Flag with five stars, proudly flies over the Treadwell plant.



Scale Table with Pushoffs and Cradles — in background Caster Bed and Transfer Tables.

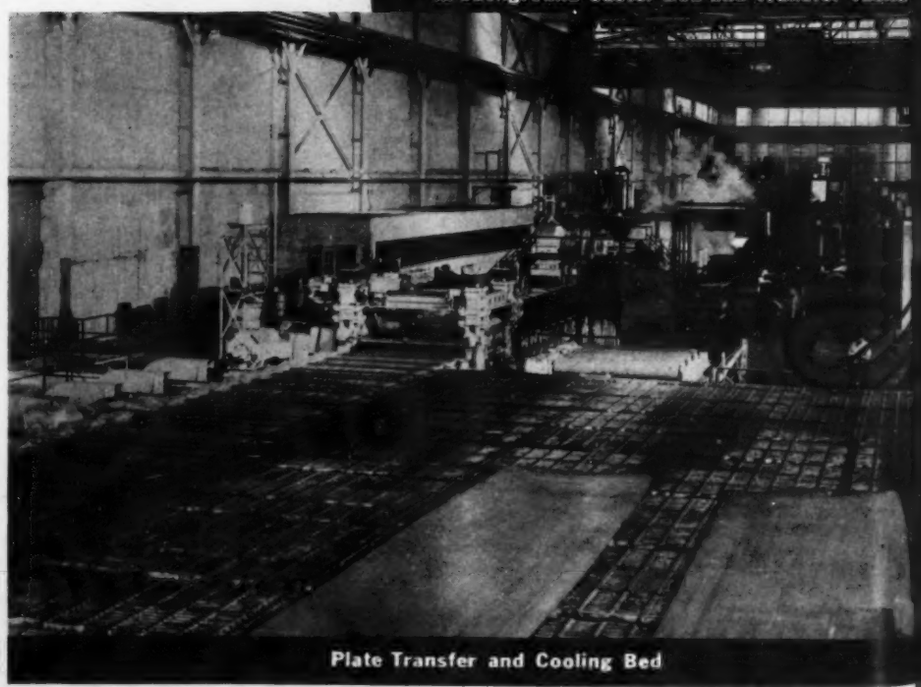


Plate Transfer and Cooling Bed

Cold Rolling Mills
Tables and Transfers
Cooling Beds
Coilers — Hot and Cold Strip
Merchant Mills
Special Machinery
Steel and Iron Castings

★ ★ ★ ★

TREADWELL ENGINEERING COMPANY

EASTON, PENNA.

SALES OFFICES: — 2113 Farmers Bank Building, Pittsburgh 22, Penn.—140 Cedar Street, New York 6, N. Y.
208 South La Salle Street, Chicago 4, Ill.

Whiting Cranes do the *Heavy* work

Whiting 25-ton Crane in the west billet yard.

125-Ton Whiting Crane used in the structural mill—shown moving one of the mill's rolls for installation.

A 10-ton crane places a mold on an ingot buggy—in the ingot mold preparation yard.

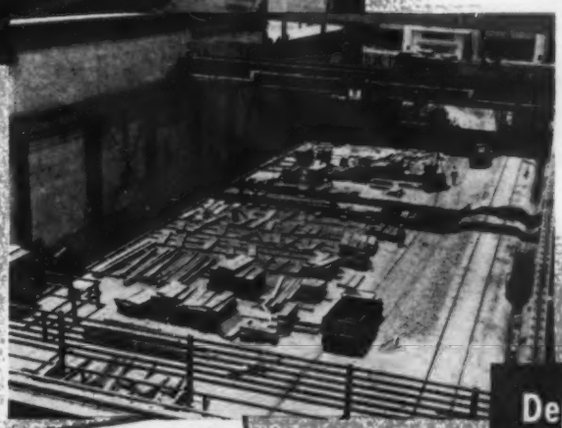
in Kaiser's Steel Plant at Fontana

In steel plants built for maximum efficiency—like the Kaiser Company's plant at Fontana, Calif.—liberal use is made of overhead traveling cranes for handling materials.

Twenty-four Whiting Cranes are in service at the Fontana plant, ranging in capacity from 10 to 125 tons, with spans from 50 to 108 feet. Several are equipped with 10 to 25 ton auxiliary hoists.

For more efficient materials-handling in *your* plant, consult Whiting engineers. Whiting Corporation, 15655 Lathrop Ave., Harvey, Illinois.

Another view of the west billet yard serviced by a Whiting 25-ton Crane.



View in the east billet yard, showing a Whiting 25-ton Crane at work.

BUILDERS OF QUALITY CRANES

FOR OVER 60 YEARS

Offices in Chicago, Cincinnati, Detroit, Los Angeles, New York, Philadelphia, Pittsburgh, St. Louis, and Washington, D. C. Agents in other principal cities. Canadian Subsidiary: Whiting Corporation (Canada) Ltd., Toronto, Ontario.

Dependable · · Quiet-Running · · Durable

WHITING

Overhead Traveling **CRANES**

GIVES YOU MORE CLEAN BILLETS THROUGH STEADY PRODUCTION

The Billeteer is dependable—it stays put. It has no ambitions, appetites, or temperament. It cannot be attracted to more desirable jobs. It's a machine!

The Billeteer is a billet cleaning department in itself. It will do the work of ten to fifteen men each 8 hour turn, thus giving the equivalent of approximately 40 men, single turn. This speeds output and cuts chipping costs. Further, the Billeteer makes possible the use of billets from bad heats by speedily cleaning up deep flaws; removal of these by manual chipping would be prohibitively expensive.

The Billeteer makes billet-cleaning a semi-skilled job and allows the operator a degree of pride in his work. This one factor of human nature contributes tremendously to employee loyalty and steady production.

The Billeteer is a preferred production investment which we feel you should investigate thoroughly. On your request we will send an illustrated brochure, and refer you to executives whose plants use Billeteers.

ADDRESS CORRESPONDENCE TO THE
STEEL EQUIPMENT DIVISION

Engineered for
Bomot
THE BOMOT ENGINEERING CORPORATION

BUILDERS OF **THE BILLETEER**

Tapered Roller TIMKEN BEARING EQUIPPED

MECHANIZE YOUR BILLET CONDITIONING NOW!

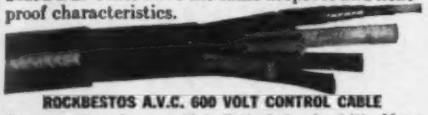
For Severe Conditions

Permanently Insulated ROCKBESTOS Wires, Cables and Cords

ROCKBESTOS A.V.C. 600 VOLT SWITCHBOARD WIRE
(National Electrical Code, Type AVB)

Sizes No. 18 to No. 4/0 AWG with varnished cambric and impregnated asbestos insulation and gray, black, white or colored flameproof braid.

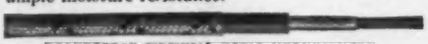
Combine fire insurance and fine appearance in your switchboards with Rockbestos Switchboard Wire. It is fireproof and will not dry out under heat. Sharp, clean bends can be made without cracking as the asbestos wall acts as a cushion under the braid. Rockbestos A.V.C. Hinge Cable and Switchboard Bus Cable have the same fireproof and heatproof characteristics.



ROCKBESTOS A.V.C. 600 VOLT CONTROL CABLE

In one to 19 conductors with individuals insulated like Motor Lead Cable, cotton braid covered and cabled with an asbestos braid over all. Standard strandings AWG No. 12—19/25 and No. 9—19/22. Other strandings on order.

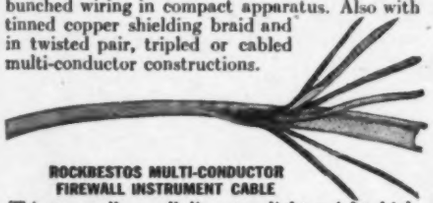
Designed for use in equipment requiring a multi-conductor control cable capable of withstanding high temperatures, this cable is widely used in the control systems of electric cranes manufactured for use in steel mills. The insulation is unaffected by heat, corrosive fumes, oil or grease and has ample moisture resistance.



ROCKBESTOS FIREWALL RADIO HOOKUP WIRE

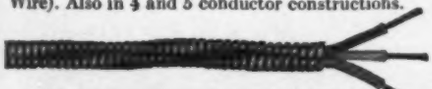
Sizes No. 22 to 4 AWG in 1000 volt rating, and No. 12, 14 and 16 AWG in 3000 volt insulated with high dielectric synthetic tape, impregnated felted asbestos and covered with color coded lacquered glass braid.

The first small diameter heat and flame resistant high-dielectric hookup wire, designed in 1937 and approved by the C.A.A. for use in airborne radio equipment. Widely used since in automotive and ground communications systems, electronic devices and apparatus. Operating temperature range 125° C. to minus 50° C. Ideal for small motor, coil, transformer and dynamotor leads and bunched wiring in compact apparatus. Also with tinned copper shielding braid and in twisted pair, tripled or cabled multi-conductor constructions.



ROCKBESTOS MULTI-CONDUCTOR FIREWALL INSTRUMENT CABLE

This unusually small diameter, light weight, high-dielectric 3 conductor No. 26 AWG cable, with individuals insulated like our Radio Hookup Wire, was designed for an electronic device in which three No. 22 AWG single conductor aircraft wires proved too bulky. It is made to a nominal diameter of .125" (smaller than a 14 AWG single conductor 1000 volt Rockbestos Firewall Radio Hookup Wire). Also in 4 and 5 conductor constructions.



ROCKBESTOS THERMOSTAT CONTROL WIRE

Sizes No. 14, 16 and 18 AWG in two to six conductors with .0125", or .025" or (for 115 volt service) .031" of impregnated felted asbestos insulation and steel armor.

A multi-conductor control wire for low voltage intercommunicating, signal, and temperature control systems. Lifetime heatproof, fireproof insulation and rugged steel armor give troubleproof circuits.

ROCKBESTOS ASBESTOS INSULATED MAGNET WIRE

Round, square and rectangular asbestos insulated conductors finished to meet varying winding conditions and coil treatment requirements.

Protect your motors against heat-induced breakdowns with class B windings of Rockbestos Heat-Resisting Magnet Wire. Leads of Rockbestos A.V.C. Motor Lead Cable will complete the failure-proofing.

ROCKBESTOS APPARATUS HEATING CABLE

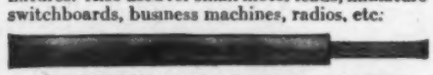
No. 19 AWG nickel-chromium resistance wire insulated with .040" of impregnated felted asbestos and covered with 4/64" waterproof lead sheath.

Manufacturers of photographic developing tanks, dry print developing machines, candy making equipment, soil heating cable kits and other devices requiring controlled distribution of mild heat can use this pliable heating cable to advantage. Also useful in preventing freezing of water pipes and congealing of oil, grease, ink, paint and sluggish fluids in conveyor pipes.

ROCKBESTOS 300 VOLT HEAT RESISTING FIXTURE WIRE
(Underwriters' Type AF)

Sizes No. 10 to 18 AWG stranded plain copper conductor insulated with black or white impregnated felted asbestos—with or without braid.

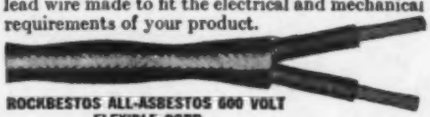
Rockbestos asbestos insulated fixture wires, approved by the Underwriters' Laboratories, are ideal for lighting fixture wiring because their heat resistant insulation will not bake out under the high socket temperatures developed in modern fixtures. Also used for small motor leads, miniature switchboards, business machines, radios, etc.



ROCKBESTOS ALL-ASBESTOS APPLIANCE LEAD WIRE

Sizes No 8 to 20 AWG solid or stranded copper, monel or nickel conductors insulated with .031" or .040" of impregnated felted asbestos in black, white or colors.

Whether you make waffle irons, hot-plates, small motors, ranges, water heaters, radios, ovens or blueprint machines, we can give you an asbestos lead wire made to fit the electrical and mechanical requirements of your product.



ROCKBESTOS ALL-ASBESTOS 600 VOLT FLEXIBLE CORD

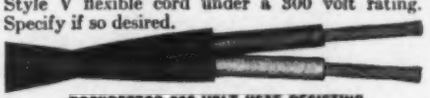
Sizes No. 10 to 18 AWG with two or three conductors insulated with impregnated felted asbestos and covered with a heavy asbestos braid.

This heavy duty heat-resisting flexible cord is ideal for high wattage lighting units, apparatus, floodlights, etc., that are used in hot spots or develop heat in operation. For moisture resistant type specify the Rockbestos A.V.C. construction described below.

ROCKBESTOS A.V.C. 600 VOLT FLEXIBLE CORD

Sizes No. 10 to 18 AWG with two or three conductors insulated with impregnated felted asbestos, varnished cambric, felted asbestos and covered with a heavy impregnated asbestos braid.

For applications such as mentioned above in which heavy duty, high-dielectric, heat and moisture resistant flexible cord is required we recommend this construction with individual conductors insulated exactly like Rockbestos A.V.C. Motor Lead Cable. Approved for lighting applications, with polarized conductors, by Underwriters' as Style V flexible cord under a 300 volt rating. Specify if so desired.



ROCKBESTOS 300 VOLT HEAT RESISTING DUPLEX FLEXIBLE CORD
(Underwriters' Type AFPD)

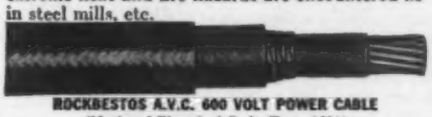
Sizes No. 10 to 18 AWG stranded plain copper conductors insulated with impregnated felted asbestos, polarized, twisted together and covered with a cotton braid.

This duplex heat resisting flexible cord is approved by the Underwriters' Laboratories for use in fixtures and is recommended for pendant types as the asbestos insulation will not dry out or crack at the socket. It provides protection against wire-failure, eliminates fire-hazard and gives permanent suspension as it does not deteriorate with heat or age. Also in twisted pair, tripled and triplex.

ROCKBESTOS A.V.C. 600 VOLT MOTOR LEAD CABLE
(National Electrical Code, Type AVA)

Size No. 18 AWG to 1,000,000 CM insulated with two walls of impregnated asbestos and a high-dielectric varnished cambric insert, with a heavy asbestos braid overall.

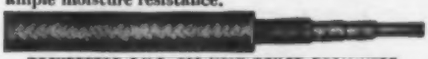
Heatproof, fireproof, greaseproof and oilproof, will not dry out and crack, won't burn or carry flame, and remains permanently flexible For coil connections, motor and transformer leads where extreme heat and fire hazards are encountered as in steel mills, etc.



ROCKBESTOS A.V.C. 600 VOLT POWER CABLE
(National Electrical Code, Type AVA)

Sizes No. 18 AWG to 1,000,000 CM insulated with laminated felted asbestos, varnished cambric, and asbestos braid Other constructions for service voltages to 5000.

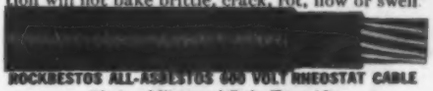
Use Rockbestos A.V.C Power Cable for the internal wiring and power leads of heat-exposed heavy electrical equipment and hot-spot wiring in conduit around boiler rooms, steam lines, furnaces, etc., as it withstands high temperatures and has ample moisture resistance.



ROCKBESTOS A.V.C. 600 VOLT BOILER ROOM WIRE
(National Electrical Code, Type AVA)

Sizes No. 18 to 8 AWG insulated with varnished cambric, impregnated felted asbestos and asbestos braid. Sizes 6 to 4/0 have another wall of impregnated asbestos next to the conductor

For lighting and control circuits exposed to heat and moisture, oil, grease, corrosive fumes or fire hazard, such as exist around furnaces, ovens, lehrs, soaking pits, boilers, etc., this widely used A.V.C. construction is ideal. Its permanent insulation will not bake brittle, crack, rot, flow or swell.



ROCKBESTOS ALL-ASBESTOS 600 VOLT RHEOSTAT CABLE
(National Electrical Code, Type AI)

Sizes No. 18 AWG to 1,000,000 CM insulated with a heavy wall of felted asbestos, covered with a rugged asbestos braid finished in black, white or colors.

Use this power and rheostat cable for wiring rheostats, switchboards, elevator and locomotive control panels and electrical equipment exposed to heat, fumes and fire hazard. Also for general open wiring in dry, high temperature locations. For flexible stranded conductor specify Rockbestos All-Asbestos Flexible Apparatus Cable. For solid conductor specify Rockbestos All-Asbestos Rheostat Wire.

A few of the National Electrical Code types and other constructions in the Rockbestos line of 125 different *permanently insulated* wires, cables and cords designed to give long-lived, dependable service under severe operating conditions — all built to resist such wire-destroying hazards as heat and moisture, oil, grease, corrosive fumes and flame. For complete information or samples, write to:

Rockbestos Products Corporation
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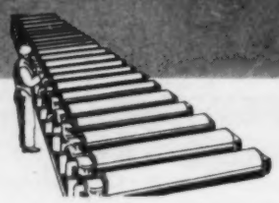
RESIST **Heat, Moisture, Oil, Grease And Fumes** ***WON'T*** **Bake Brittle, Bloom, Burn or Rot**

SCHLOEMANN
"Motor-Rollers"



Schloemann engineers have designed "Motor-Rollers" with a view toward increasing efficiency and lowering operating costs by simplifying electrical and mechanical requirements. Design simplification lowers maintenance expenses on shear, scale and mill tables.

Each Schloemann "Motor-Roller" is individually powered by a squirrel cage motor, housed in a free turning shell on anti-friction bearings, assuring flexibility of movement. The stator has no electrical connection to the rotor and represents the simplest piece of apparatus for converting electrical energy to mechanical work.

Our engineering staff is prepared to assist you with your mill table problems. We invite your inquiries for additional information or consultation with our representatives.

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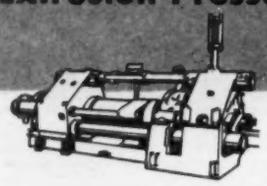
Extrusion Presses



Schloemann Presses are designed for the efficient extrusion of tubular products, rods, bars and all types of sections, strip and wire rods. They are recognized as efficient tools for shaping non-ferrous metals to dimensions within close tolerances.

Among the outstanding details of design is Schloemann's patented support of the platen and container holder in the centerline of the container. The independent movement of the mandrel from the press stem enables the piercing of copper, and commercial steel alloys from billets cast solid.

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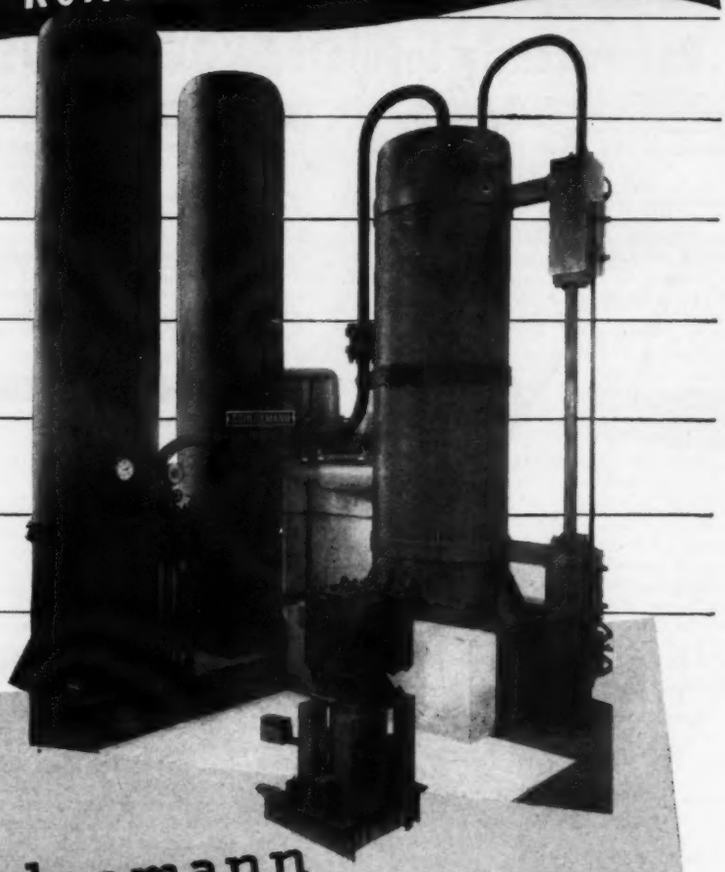

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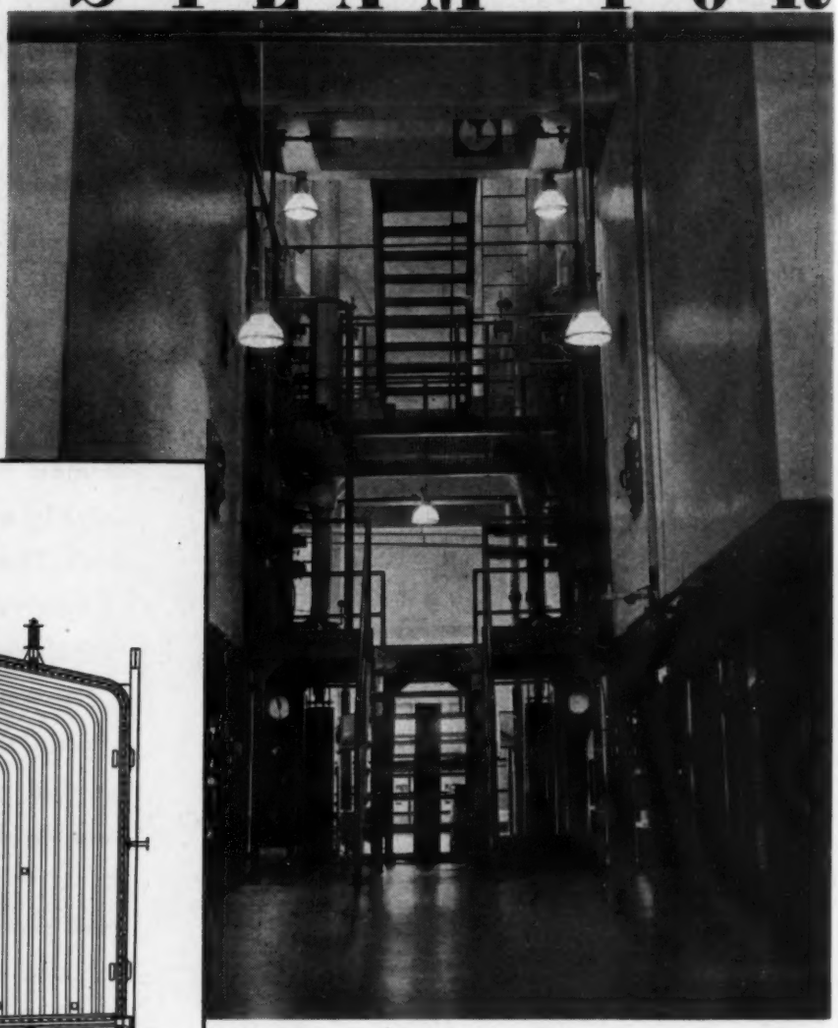
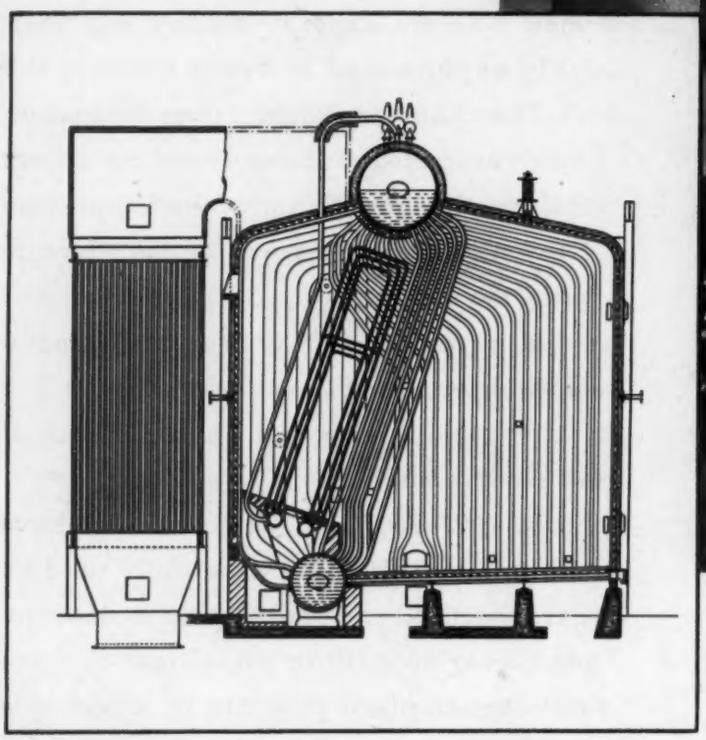
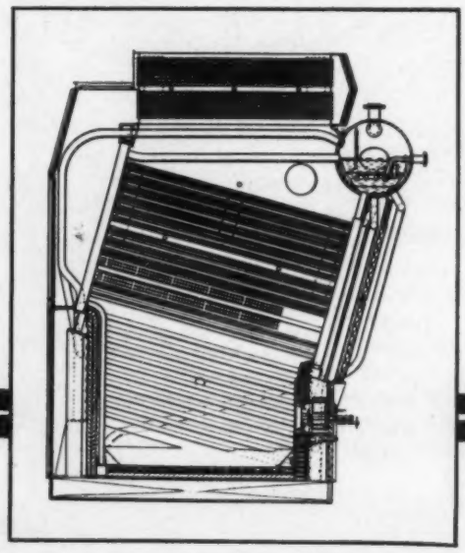


Installation of B&W Integral Furnace Boilers at Fontana Steel Plant.



AT KAISER COMPANY STEEL PLANT - B&W Integral-Furnace Boiler—capacity 160,000 lb. steam per hr. Two units of this size and one of 105,000 lb. capacity supply superheated steam at 475 psi, 700—750 F.

. . . ON KAISER-BUILT SHIPS, TOO
B&W Single-Pass, Header-Type Marine Boiler—a design used on many Kaiser-built ships.



FONTANA...

Power house at Kaiser steel plant, Fontana, Cal.

...another job for B&W Integral Furnace Boilers

At the Kaiser Company's Fontana steel plant . . . where steel plate is produced for Kaiser-built ships . . . B&W Boilers provide all steam requirements for coke plant turbines and by-product processes, blast furnace turbo-blowers, and other mill services.

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This modern plant joins a long list of steel mills, chemical plants, refineries, ordnance and aircraft plants in which B&W Boilers have proved dependable in war production as in pre-war services.

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WRITE FOR BULLETIN ON RYERTEX BEARING APPLICATIONS

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CLEVELANDS in the West Coast Steel Industry

ANOTHER great name is added to "Cleveland's" Honor Roll in the Steel Industry. Another major Cleveland-equipped project goes into production—its owners profiting by the experience that this Company has gained in serving the Industry for nearly 30 years.

In this outstanding West Coast Mill, Cleveland Worm Gears are driving the Ingot Buggies, Furnace Tables, Slab Pushers, Vertical Edgers, Shears, Leveller, Runout Tables, Transfers, and Turnovers, as well as the Ladle Cranes, Roll Lathes and Grinders.

"Cleveland" spells trouble-free performance anywhere in the Steel Industry—in our own home City, across the nation, or across the globe. Since 1912, Clevelands have been designed and built to take the punishment of Steel Production—have absorbed the shock loads of 24-hour Mill Operation for years on end without need for special attention or servicing.

Let Clevelands' fine performance through the years guide *your* selection of worms and gears for the future. Your nearby Cleveland Representative can give competent, experienced counsel. Better send for him today.

The Cleveland Worm & Gear Company, 3278 East 80th Street, Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication
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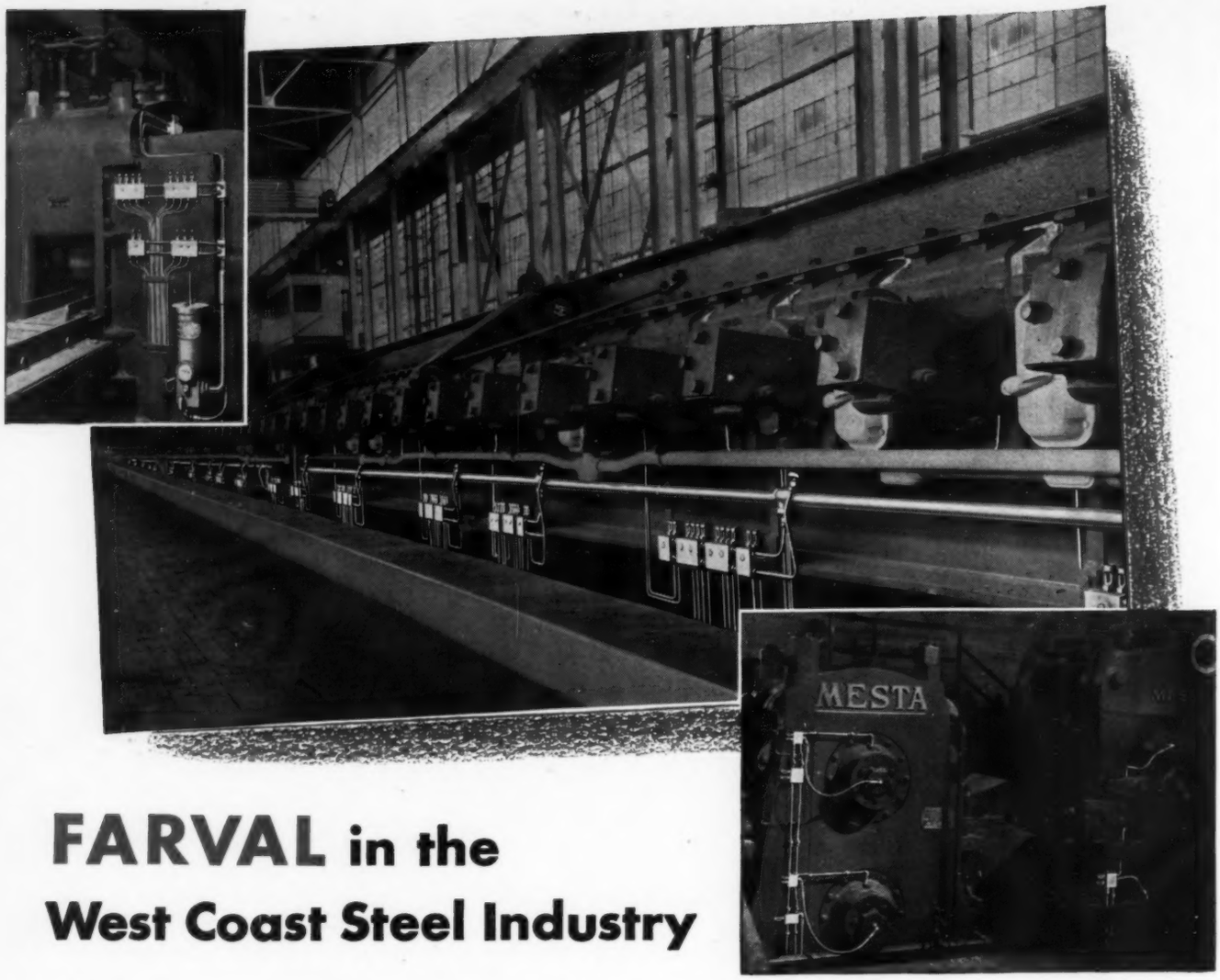
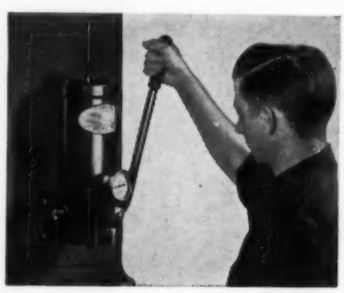
CLEVELAND
WORM GEAR
SPEED REDUCERS



FARVAL in the West Coast Steel Industry

TO insure the continuous operation of this great new Mill in California—to provide steel production on schedule to satisfy the heavy fabrication demands of West Coast Industries—the owners have installed Farval Centralized Lubricating Systems on the 14″, 18″ and 21″ Merchant Mills and all auxiliary equipment.

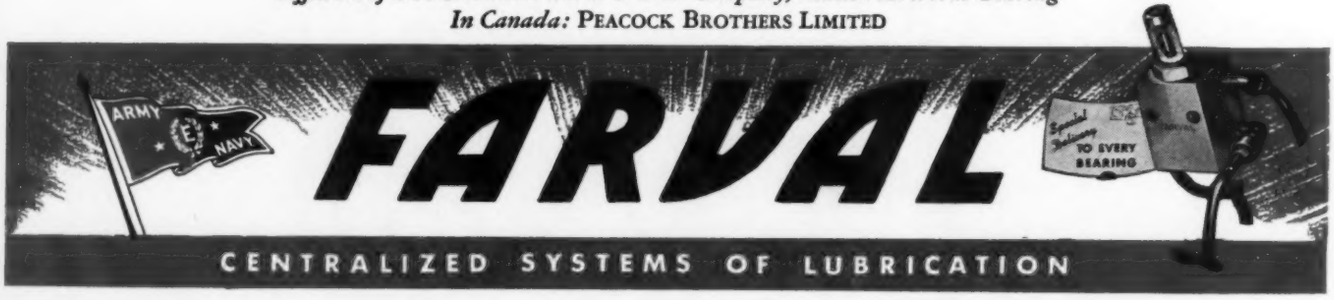
More than **75 Farval Central Stations** are delivering lubricant at regular intervals to each of **4,509 individual bearings** on the Mill Stands, Furnace Pushers, Tables, Shears, Transfers, Pinch Rolls, Hot Saw, Cooling Beds, Piler, Car Dumper and Overhead Cranes.



Thus on the West Coast, as well as throughout other Steel-Producing Districts, Farval Centralized Systems continue their 18-year proven record for increasing output and reducing costs. Install Farval on your Mill Equipment and you will eliminate the need for shutdowns to lubricate or to repair the lack of lubrication. Farval will increase your tonnage and prolong the life of your bearings.

It will pay you to get the newest facts on Centralized Lubrication. Your nearby Farval Representative has valuable information for you. Send for him today. The Farval Corporation, 3278 East 80th St., Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing
In Canada: PEACOCK BROTHERS LIMITED



REVERSING

Regenerative Furnaces

. . . . the use of reversal control, either signaling or fully automatic, on regenerative furnaces will result in more uniform operation, increased output and decreased refractory maintenance . . . .

by J. R. GREEN and J. P. VOLLRATH

BROWN INSTRUMENT COMPANY

PHILADELPHIA, PENNSYLVANIA

▲ MUCH engineering thought has been given to the broad problem of reversing regenerative furnaces. As a result, many systems of automatic reversal control have been developed and, as might be expected, many advantages are claimed for one method over another. Some systems are quite simple whereas others, by taking many factors into consideration, tend to become so complex that they may present a sizable maintenance problem which must be taken into consideration in arriving at a practical answer.

Fundamentally, any regenerative furnace system tends to be self balancing if a sufficient length of time is given to average out the effect of temporary unbalances such as may occur in certain types of furnaces, from operating conditions as for example charging, drawing, tapping, opening furnace doors for metal additions, making bottom, or furnace repairs.

To illustrate, with an equal fuel input when firing in each direction, an excessively long period of reversal tends not only to lower the temperature level in the preheating checker, but also increases the losses from the checker being heated and, finally, through excessive cooling of the preheating checker, may tend to lower the temperature of the checker being heated. Upon reversal, the comparatively greater heat capacity of the long heated checker delivers a larger amount of heat through the furnace to the previously "cold" checker, thus restabilizing the temperature levels in the checkers.

Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pa., Sept. 25-27, 1944

The problem is to maintain or reestablish this balancing operation after interruption by selecting a condition for reversal which produces the best combustion conditions without excessive use of fuel, and with the minimum heat loss. Although the problem of regenerator reversal is admittedly complex, especially on the higher temperature furnaces, control systems are available which are practical and have many operating advantages.

On any type of furnace the prime purposes served by the regenerators are to transfer the maximum amount of sensible heat from the waste gases to the combustion air and thus improve thermal efficiency, and to improve the flame characteristics. In the case of batch type melting furnaces as exemplified by the open hearth, the combustion air must be preheated, otherwise the high flame temperature necessary for melting and refining cannot be obtained.

FACTORS IN REGENERATOR REVERSAL CONTROL

In considering the overall problem of heat conservation and distribution in a regenerative system, the following factors should receive consideration in order to determine the most desirable set of conditions upon which the furnace should be reversed.

1. Thermal losses in exit gases from regenerators.
2. Thermal losses during reversal
   Exhausting unburned or partially burned fuel through checkers.

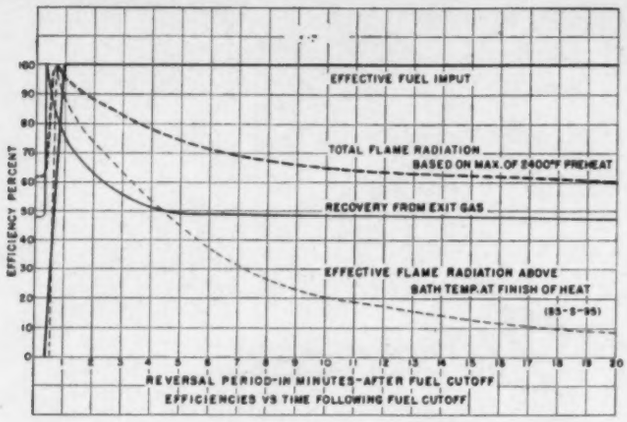

EFFECTIVE FUEL INPUT
TOTAL FLAME RADIATION
BASED ON MAX. OF 2400°F PREHEAT
RECOVERY FROM EXIT GAS
EFFECTIVE FLAME RADIATION ABOVE
BATH TEMP. AT FINISH OF HEAT
EFFICIENCY PERCENT
REVERSAL PERIOD-IN MINUTES-AFTER FUEL CUTOFF
EFFICIENCIES VS TIME FOLLOWING FUEL CUTOFF

Figure 1 — Curves giving efficiencies of fuel input, flame radiation and heat recovery at intervals after reversal.

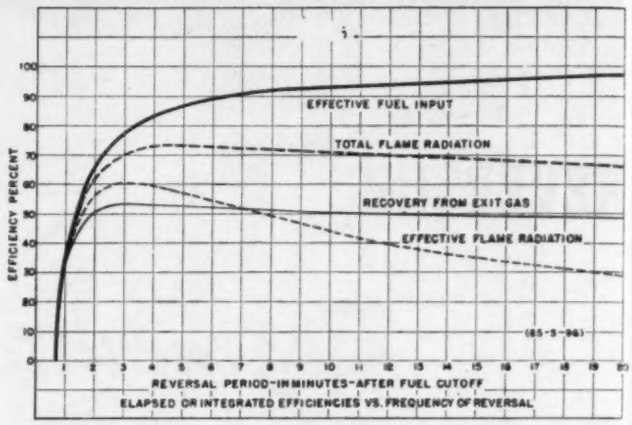

EFFECTIVE FUEL INPUT
TOTAL FLAME RADIATION
RECOVERY FROM EXIT GAS
EFFECTIVE FLAME RADIATION
EFFICIENCY PERCENT
REVERSAL PERIOD-IN MINUTES-AFTER FUEL CUTOFF
ELAPSED OR INTEGRATED EFFICIENCIES VS. FREQUENCY OF REVERSAL

Figure 2 — Curves giving integrated efficiencies of fuel input, flame radiation and heat recovery vs frequency of reversal.

Time of "fuel off."

Loss of temperature in furnace.

3. Loss of temperature in preheat of air (or fuel).
4. Maintenance of working heat head in the furnace above the temperature of the product or bath.
5. Maximum allowable temperature of the checker refractories.

Quite naturally all of these factors cannot be maintained at optimum value by any one set of conditions. The relative importance of each factor with respect to the nature of the heating operation must be considered.

To illustrate some of these factors, the curves shown in Figures 1 and 2, as applied to the operation of an open hearth, are typical examples, being based upon the latest available data by high velocity gas temperature measurements and studies of the related flame radiation characteristics. Figure 1 plots relative efficiencies of several factors as they exist at progressive time intervals following reversal. The recovery of heat from the checker exit gas expressed as a percentage of the waste gas temperature entering the checkers, is shown in one curve. The heat input in the form of fuel is shown in another curve.

Although the "fuel off" time may be 15 to 20 seconds or less, and full fuel rates with good combustion conditions established within another 20 to 30 seconds, operating practice definitely indicates that a considerably longer period exists, following each reversal operation, before the heat losses from the bath and furnace during reversal have been regained and an effective working heat head has been established. This emphasizes the importance of doing everything possible during the reversing operation by means of furnace pressure, air flow and fuel flow rate to purge the outgoing checkers, readmit a full volume of air to the oncoming burner point, and readmit fuel under good combustion conditions in the shortest possible period of time.

A third curve shows the approximate effect of progressively changing preheated air temperatures on the total radiating power of the flames. This might represent the effect in a cold furnace. Another curve represents similar effects on flame radiation characteristics in the maintenance of a working heat head above the bath temperature during the final stage of a heat.

Since the reversal operation is cyclic and its overall effectiveness must include conditions at the beginning as well as the end of each regenerative period, the integrated or elapsed efficiencies at the end of various time periods, are shown in Figure 2 for the same factors.

The actual values as well as the slopes of such curves will of course depend upon the size, construction and condition of individual furnaces, but the general shape of these typical curves can be used for study of the problem.

OPERATING CHARACTERISTICS OF REGENERATIVE FURNACES

For purposes of comparative analysis, regenerative furnaces, as used in the steel industry, might suitably be divided into three principal classifications:

1. Continuous reheating furnaces at relatively medium furnace temperatures (2400 F and below) for example: Billet or slab heating furnaces, welding furnaces, etc.
2. Batch reheating furnaces at the same relative temperature range, for example: Soaking pits, batch billet heaters, etc.
3. Batch type melting and refining furnaces at high temperatures, for example: Open hearth furnaces.

TABLE I

TABULATION OF PRINCIPAL TYPES OF REGENERATIVE FURNACES AND WEIGHTED VALUES SHOWING THE RELATIVE IMPORTANCE OF THE PRINCIPAL OPERATING FACTORS

	MEDIUM TEMPERATURE		HIGH TEMPERATURE		
	CONTINUOUS REHEATING FURNACES	BATCH REHEATING FURNACES	CONTINUOUS MELTING FURNACES	BATCH TYPE MELTING FURNACE	
				FINAL PERIOD	INITIAL HEATING PERIOD
LOSS IN EXIT GAS TEMPERATURE	1	1	5	5	1
LOSS IN CHECKER TEMPERATURE DURING REVERSAL	3	2	4	4	2
LOSS IN PREHEAT TEMPERATURE	2	4	3	3	4
MAXIMUM REFRACTORY TEMPERATURE	4	5	2	2	5
MAINTENANCE OF HIGH FURNACE TEMPERATURE	5	3	1	1	3

Considering the continuous medium temperature reheating furnace with respect to all phases of the problem, the heating rate is quite constant with the exception of holding periods when the heat head above the product must be materially reduced. The loss due to exit gases is relatively more important than the loss of preheat, since the maximum possible air temperature is not usually required in order to maintain the desired furnace temperature. The losses due to reversal are not a major factor for the same reason.

The principal difference between the batch and continuous types of medium temperature reheating furnaces is that the heating rate progressively decreases throughout the heating cycle. Simultaneous with the decrease in heating rate, the temperatures of both the exit gas and preheated air increase as the charge is brought up to rolling temperatures.

In general, batch reheating furnaces have the same relative importance of reversal characteristics as continuous reheating furnaces with the exception that during drawing operations the maintenance of high furnace temperatures and corresponding low losses in checker temperature during reversal assume greater importance.

The problem of the batch type high temperature melting or refining furnace, such as the open hearth, is the most complex because of its primary requirements. These include all available preheat in order to maintain a heat head in the furnace, prevention of excessive top checker temperatures, progressively higher temperature levels in the checkers throughout the course of the heat, and a variable fuel rate consistent with best operating practice during bath reactions. In addition, this type of furnace operation is subjected to numerous interruptions in regular operation such as door openings for charging, hot metal and ore additions, all of which tend to temporarily unbalance the furnace.

In Table I is given a numerical order of relative importance of the various operating factors for the principal types of regenerative furnaces. This tabulation will be helpful in selecting the most desirable reversal control system for a given furnace.

Based upon this listing of relative importance as applied to the initial and final period of a typical open hearth heat, and using values from the previous curves, overall efficiencies plotted against the time of reversal period are shown in Figure 3. The desirability of progressing from relatively long to short periods of reversal during the course of each heat is apparent, and is borne out in good operating practice. Again the actual values in times and efficiencies will be dependent upon each furnace construction and condition.

MEASUREMENT OF REGENERATIVE TEMPERATURES

At this point, consideration can well be given to the means and characteristics of the several kinds of available temperature measuring devices when used to measure checker temperatures. It should be noted that regardless of the type of furnace, the prime purpose of regeneration is to either conserve heat or to obtain high flame temperatures. With this established, it is logical that any system of regenerator reversal control for any type of furnace should be based on a factor which is at least closely related to temperature conditions within the regenerators.

Depending upon the type of furnace and its operating temperatures, checker temperatures may vary from 1800 to 2500 F at the furnace or "hot end," down to 400 to 1400 F at the exit or "outlet-inlet." Figure 4 illustrates in a conventional way an open hearth furnace with its regenerator chambers folded out. On this illustration, typical operating temperatures are given at the points shown. The maximum and minimum temperatures in many cases may vary from those given but the temperature gradient will probably be comparable to that shown on the illustration.

Thermocouples or radiation pyrometers may be used for measuring the checker temperatures, the former where temperature conditions are favorable to thermocouple life such as at or near the outlet flues. The latter are used where high temperature exists such as above the checkerwork.

When interest was first aroused in checker temperatures, measurements were made in the high temperature zones with platinum thermocouples. The severe conditions of melting furnace service resulted in such high maintenance and replacement costs that the point of temperature measurement was progressively moved toward the outlet flues where conditions are more favorable to thermocouple life. Such a measure does not provide the most desirable information for reversing some types of furnaces since it is only a measurement of exit losses.

Ideally, a measure of the true air or gas temperatures

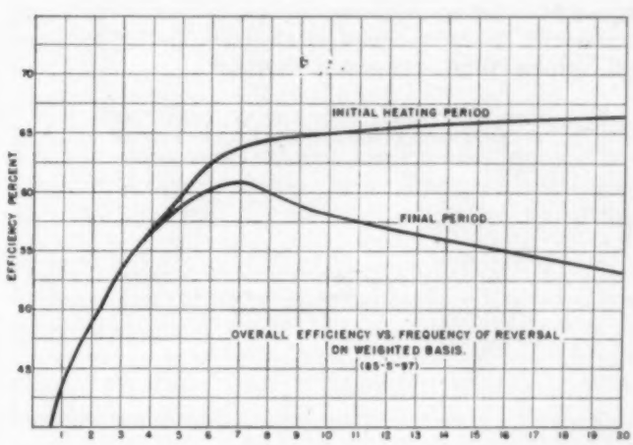
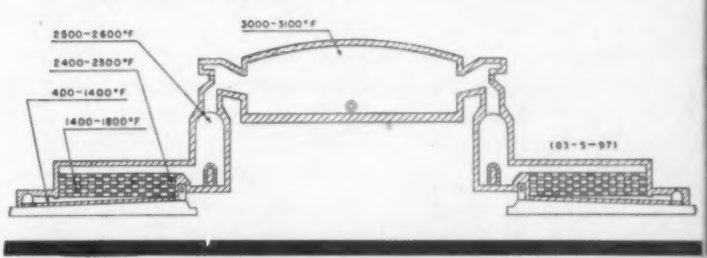


Figure 3 — Overall efficiencies vary materially during the open hearth heat, indicating the desirability of shortening reversal periods as the heat progresses.

Figure 4 — Sketch of open hearth furnace with regenerators folded back, with typical operating temperatures shown at various points.

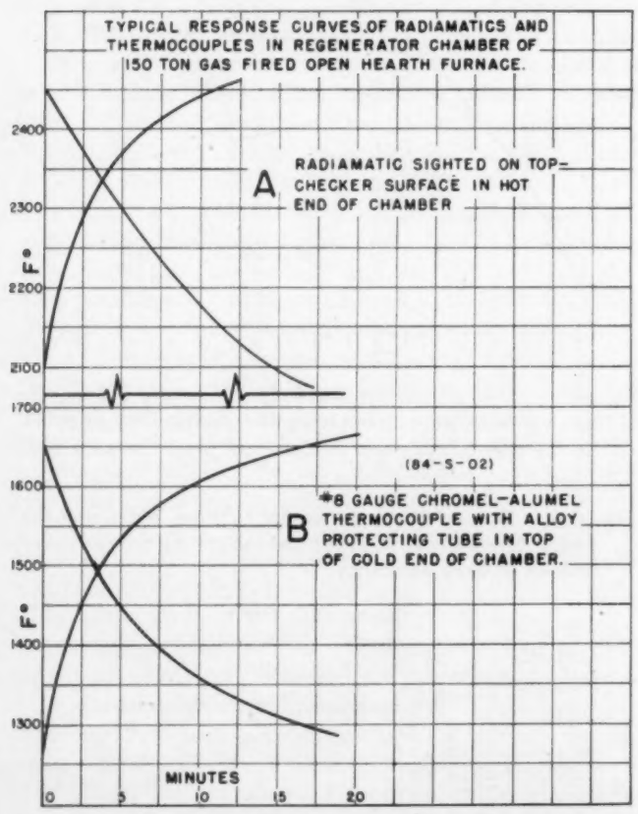


entering or leaving the furnace proper would be of greatest operating value. Unfortunately, the inherent difficulties attendant with aspirating thermocouples and similar gas temperature measuring apparatus have shown that, to date, no practical method exists for the continuous measurement of gas temperatures. However, a practical approach is provided by measuring the surface temperature of a relatively large area of the top course of checker brick or of the chamber roof with radiation pyrometers.

By this method of measurement, the disadvantages of maintenance and single point measurement by a thermocouple is eliminated. The surface conditions of the refractories sighted upon have practically no effect upon the measurement since the conditions of the checker chamber approach those of a "black body." Any variation in temperature between different top-course areas, caused by uneven restriction to gas flow, will produce radiation readings which are nearer the hottest temperature (and not the average) because of the inherent fourth power characteristics of radiation measurements.

Comparisons between temperature measurements made by thermocouples and radiation pyrometers in a 150 ton basic open hearth furnace are shown in Figure 5. The respective cooling and heating rates indicate a much closer relationship between radiation measurements and the actual air and gas temperatures. With thermocouples installed in the flues, the cooling curve would drop rapidly to atmospheric temperature if it were not for the thermal lag presented by the protecting tube and its response to the radiant heat from the flue walls. Such a cooling rate curve also is dependent, to a considerable degree, upon the rate of air flow past the thermocouple. It is obvious that such a measurement bears no relation to the temperature of the preheated air.

Figure 5 — Typical response curves of radiation pyrometers (A) at hot end of checkers and of thermocouples (B) at cold end of chamber.



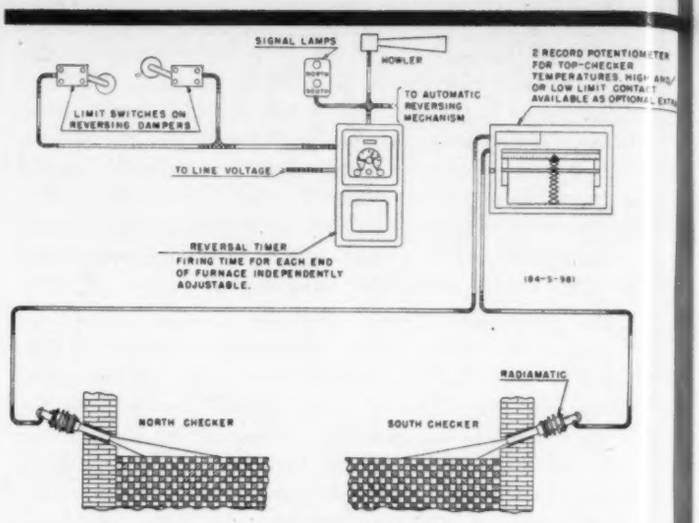


Figure 6 — Basic time reversal system (manual) with separate top checker temperature records.

If thermocouples are located at any intermediate point in the checker system, the same comparison holds but to a lesser degree, because the closer the measurement is made to the hot end, the closer the relationship to actual preheat temperature. Any intermediate local points do not show the average temperature of all the gases flowing through the regenerator.

In addition to providing a measurement indicative of the preheat temperature, measurement by radiation has many other advantages for this application which include:

1. A direct measure of the maximum refractory temperature in the hottest part of the checker chamber and effectively guards against overheating.

   During bath reactions, large volumes of combustible gases are sometimes released causing secondary combustion in the checker chamber with consequent overheating. The radiation pyrometer recognizes any and all temperature variations even if they exist for only a few seconds.
2. Long service life. The radiation element "views" temperature conditions from a relatively cool location. It is not exposed to furnace atmospheres.
3. It responds rapidly to every change in checker brick temperature.
4. Being a radiation device, it has fourth power calibration characteristics, i.e., the higher the temperature of the target sighted upon, the higher the electromotive force output per degree. On certain types of automatic signaling or control systems, this characteristic at higher temperatures causes reversal more frequently as the furnace temperature increases.

SIGNALING VS FULL AUTOMATIC CONTROL

Regenerator reversal from measuring instruments may be carried out in two ways, i.e., signaling (semi-

automatic) or fully automatic. The decision as to which system to use should be made only after careful consideration has been given to numerous local conditions, such as cost and ease of mechanizing existing reversing equipment, ability of maintenance personnel to keep the equipment operating and other similar factors.

With a signaling system, the instrument simply actuates howlers, bells or lamps which warn the operator when reversals should be made. No change whatever is required to existing equipment; reversals are carried out manually the same as before. Obviously, such a system requires a materially smaller initial investment than a full automatic system. An important advantage of a signaling system is that the operator recognizes that the responsibility of furnace operation definitely remains in his hands. He is more apt to recognize what is always true, i.e., that any such devices are tools and if used properly are of considerable operating value.

With full automatic control, the measuring instruments shut off fuel, initiate the reversing mechanism and readmit fuel to the opposite end of the furnace as rapidly as good combustion practice permits. The cost of a full automatic reversal system may be justified where faster reversals can be secured without sacrificing good combustion practice.

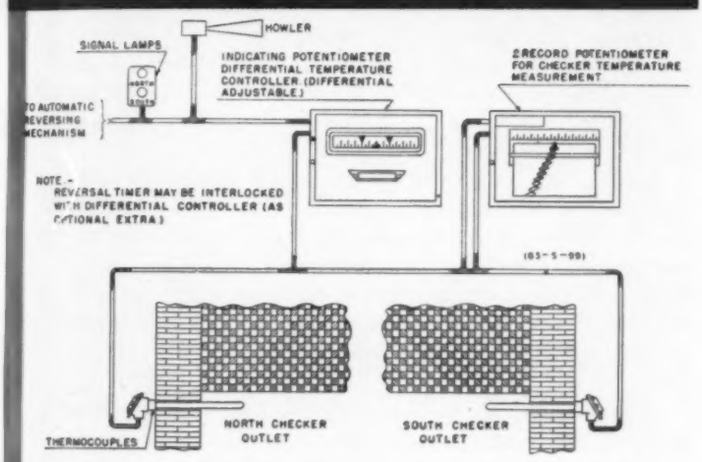
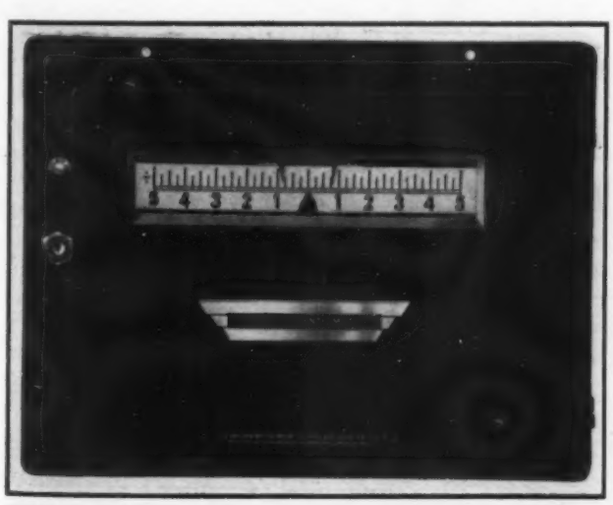

HOWLER
SIGNAL LAMPS
INDICATING POTENTIOMETER DIFFERENTIAL TEMPERATURE CONTROLLER (DIFFERENTIAL ADJUSTABLE)
RECORD POTENTIOMETER FOR CHECKER TEMPERATURE MEASUREMENT
TO AUTOMATIC REVERSING MECHANISM
NOTE - REVERSAL TIMER MAY BE INTERLOCKED WITH DIFFERENTIAL CONTROLLER (AS OPTIONAL EXTRA)
THERMOCOUPLES
NORTH CHECKER OUTLET
SOUTH CHECKER OUTLET

Figure 7 — Temperature difference reversal system based on thermocouple measurements, with separate instruments for checker temperatures.

▲

Figure 8 — Indicating differential control potentiometer pyrometer used in system shown in Figure 7.



METHODS OF INITIATING REGENERATOR REVERSAL

At the present time, four distinctly different methods are used to control regenerator reversals. With one method, reversals are made strictly on a measured time basis whereas with the others, temperature measurements are either used alone or are interlocked with timing devices. Any of these systems can be used for signaling or full automatic reversal control.

Automatic time reversal — This system is designed to maintain checker balance by firing each end of the furnace for fixed lengths of time. The system does not recognize changing temperature conditions of the regenerators but can be periodically adjusted, hence maximum protection is not provided if damaging temperatures are likely to be attained.

Even when time reversal is used, separate measurements of checker temperature are always recommended. The operator can then adjust manually the length of firing periods to maintain desired temperature conditions.

Figure 6 illustrates a manual reversal by time system. It usually consists of an automatic timer, signal lamps or howler and a pair of switches which are operated by the air reversing valves. In operation, the timer motor operates until the predetermined time interval has elapsed after which the signal system is operated and the timer motor stops. The operator then manually reverses the furnace in the usual way. When the combustion air valves are completely reversed, the proper switches make contact, automatically resetting the timer and starting a new firing period.

With full automatic time reversal control, a sequence timer is associated with the basic timing mechanism. Individual independently adjustable means are provided for shutting off the fuel, reversing the combustion air and waste gas flow, etc. so that the speed of reversal can be adjusted to meet local conditions.

Time reversal is used extensively on applications where the temperature of the preheated combustion air or waste gases is not a critical factor such as on continuous and batch type reheating furnaces. It should be again noted that on all these applications, the time reversal system should be augmented with checker temperature recording equipment.

Temperature difference reversal systems — This system is designed to maintain balance checker conditions irrespective of the temperature level at which the checkers are operated and therefore find its principal application on batch type furnaces. The system in its simplest form does not recognize the actual temperature of either checker but as its name implies, depends upon the temperature difference between the checkers.

Referring to Figure 7, this system consists essentially of two temperature responsive elements connected in opposition (one for each checker) and an instrument (Figure 8) which indicates the difference in temperature between the two elements.

The instrument is equipped with contacts which initiate reversal when predetermined temperature

differences occur. Provisions are made so that the furnace operator can conveniently readjust the desired temperature difference at any time. Also to facilitate rebalancing, provisions are made so that the operator can readjust the amount or percentage of this total difference a given checker must change to cause reversal.

Where thermocouples are used to control from waste gas differential, the reversal periods tend to be of uniform length throughout the heat. Among the advantages claimed for this system, the following predominate:

1. Since the reversals are made essentially from waste gas temperatures, the actual period of reversal is related to the working conditions of the furnace.
2. Reversal periods can be adjusted at will to suit operators' judgment. This is accomplished by increasing or decreasing the differential. Usually, the reversal periods are decreased toward the end of a heat so as to utilize the highest possible degree of air preheat.
3. Less maintenance because excessive temperature variations are prevented, hence refractory life is increased.

In contrast to the above, the following appear to be logical inherent disadvantages of a temperature difference system operated from thermocouple measurements in the outlet flues.

1. The thermocouples, being located in the cold end of the regenerator do not respond rapidly to the changes in gas temperatures entering the regenerator. Therefore, flash heating during bath reactions may cause wide temperature changes and damage the refractories in the hot end of the regenerator.
2. There is no assurance that the temperature shown by the couple on the outgoing end of the checker will always be related to the temperatures in the hot end. For example, progressive air infiltration around the checker setting definitely changes this relationship and if such a condition unknowingly exists, excessive hot-end temperatures may develop.
3. The system does not automatically recognize the actual temperature of either checker. Separate records are required to guide the operator in the selection of the proper differential so that excessive checker temperatures can be guarded against.
4. Whenever the furnace is fired in one direction beyond the fixed differential setting, as is frequently the case in open hearth practice during charging, hot metal addition, furnace observation or repairs, the following cycle will call for a firing period in the opposite direction which is of approximately equal excessive length in order to secure the desired "differential balance." Such an excessive period may cause damage to the heating checker and reduces the preheat temperature below its most effective value.

It is felt by some that radiation pyrometers, due to their fourth power characteristics, are unsuitable for the initiation of regenerator reversal with the temperature difference system. Actually, however, a closer study of this characteristic discloses that it inherently causes more frequent reversal as the temperature head in the furnace system increases. This is in keeping with established practice in many plants because, toward the end of a heat when the checkers are hottest, it usually is desired to keep the preheat temperature as high as practical, speeding furnace operation by maintaining the highest possible "working head" above the bath, and conserving fuel losses during this period of highest exit gas temperature.

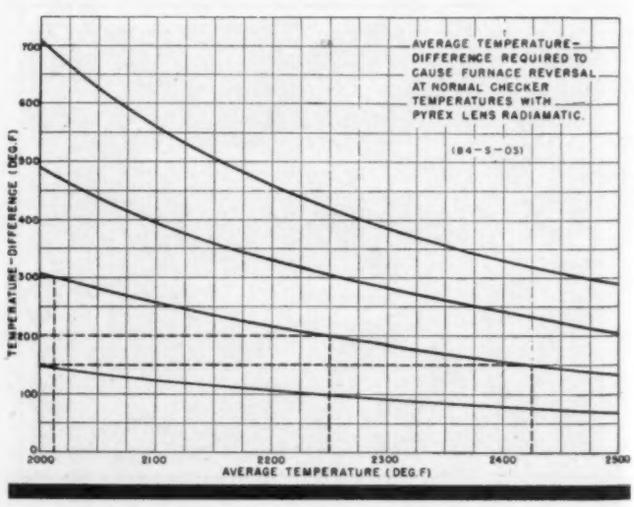
As a typical example of the temperature difference system using radiation measurements, a study was made to determine what actual difference in top checker temperature would cause furnace reversal at various average checker temperatures corresponding to all stages of a typical open hearth heat. Figure 9 illustrates what average differential temperatures would be required to cause reversal throughout the normal operating range of 2000-2500 F for average differentials at 2250 F of 100 to 400 degrees. Reference thereto discloses that if a temperature difference system based on radiation measurements is adjusted to cause reversal on a 200 degree difference at 2250 F, this difference automatically increases to about 300 degrees at 2010 F and decreases to about 150 degrees at 2425 F. For checker temperatures below 2000 F, the difference is of course greater.

It is therefore apparent that the exponential characteristics of radiation pyrometers inherently provide a driving power to the temperature difference system. It was also evident that if the average checker temperature should drop appreciably during furnace delays, long charging periods or "hot" repairs, the temperature difference controller should be augmented by an automatic timer to cause reversal at the expiration of some predetermined maximum time regardless of the checker temperature difference in order to prevent excessively long reversal periods.

Reversal systems based upon temperature difference using radiation measurements therefore eliminate the disadvantages of this system which are based upon the inability of exit temperature measurements to detect flame carryover or infiltration and are more directly influenced by loss of preheat. Such a system is illustrated in Figure 10 and the instrument used is illustrated in Figure 11.

In addition, since temperature measurements are made of the hot end conditions, (recorded on the same or a separate instrument), it is also possible to reverse from a fixed high temperature limit.

Figure 9 — The temperature difference required to cause furnace reversal varies with operating temperature as measured by radiation pyrometer.



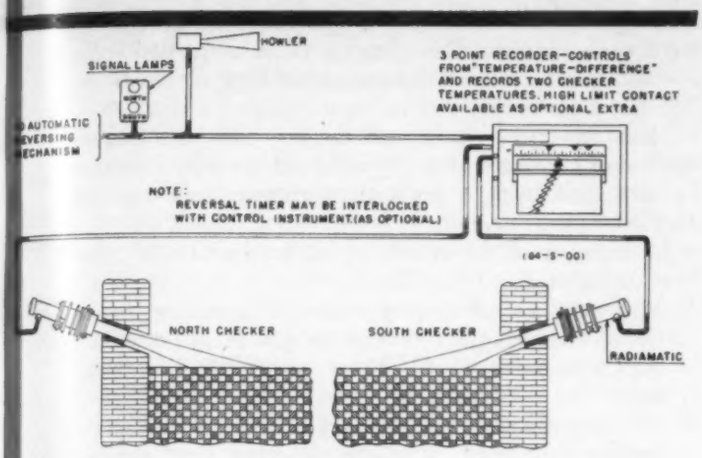
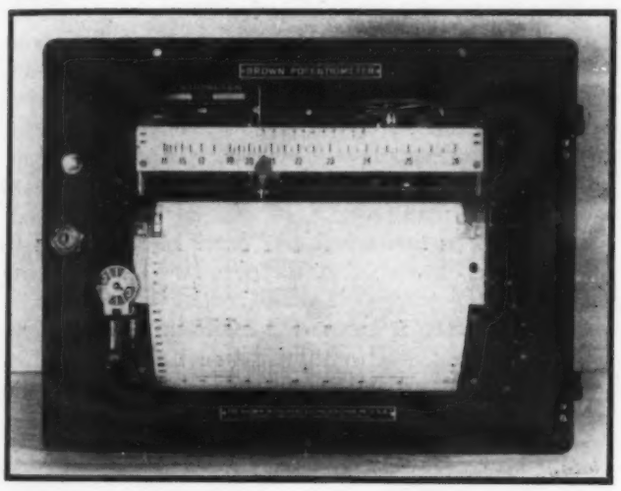

HOWLER
SIGNAL LAMPS
3 POINT RECORDER-CONTROLS FROM "TEMPERATURE-DIFFERENCE" AND RECORDS TWO CHECKER TEMPERATURES. HIGH LIMIT CONTACT AVAILABLE AS OPTIONAL EXTRA
AUTOMATIC REVERSING MECHANISM
NOTE: REVERSAL TIMER MAY BE INTERLOCKED WITH CONTROL INSTRUMENT (AS OPTIONAL)
NORTH CHECKER
SOUTH CHECKER
RADIAMATIC

Figure 10 — Temperature difference reversal system based on radiation pyrometer measurements, using only one instrument.

▲

Figure 11 — This instrument (controlling-recording) is used in connection with the system shown in Figure 10.



One further limitation of all temperature difference systems is worthy of note. Since a differential rather than an actual temperature is measured, the average of two temperature conditions is measured. An unbalance in the heat capacity of opposite checkers will cause one checker to heat and cool much faster than the other yet a differential measurement will not detect this condition.

Floating maximum temperature reversal system (interlocked with fixed excess temperature limit, minimum and maximum time) — This system is designed to initiate furnace reversal from temperature conditions in the hot ends of the checkers during their heating cycle. The basic system is augmented with automatic timers so that if reversal is not made from temperature conditions, a preset maximum timer causes reversal. Summarizing, reversal occurs under the several following conditions:

(a) When the checker being heated reaches an automatically adjusted maximum temperature, but only after the expiration of a preset minimum time.

(b) When any checker reaches a predetermined and fixed excess temperature limit, regardless of firing time.

(c) At the expiration of a predetermined maximum time, regardless of checker temperature conditions.

The control point for the floating maximum temperature condition is automatically raised until a preset minimum time has elapsed, following which reversal is initiated. It is lowered rapidly when the preset maximum time has been exceeded.

The system consists essentially of a recording potentiometer measuring two or more checker temperatures by means of radiation elements. In addition to a fixed excess temperature limit, a motorized control point mechanism is operated automatically from temperature, limited by preset timing conditions. A very complete series of automatic reset timers and relays are interlocked to perform the desired functions.

In practical operation this system initiates reversal on minimum time during the early stages of the heating, as the checker temperature sets an increasing maximum temperature control point. This minimum time may be exceeded and reversal actuated from the previous maximum temperature condition if the outgoing checker is not heating as rapidly due to door openings, lowered fuel input, etc.

Reversal periods may be shortened as required by the fixed excess temperature limits, or lengthened to a maximum during the rapid lowering of the temperature levels following tap and charge. Numerous operating advantages are claimed for this system, including the following:

1. The excess temperature limit reversal feature, possible at any time, prevents overheating of the checker brick as well as protects the end walls and downtakes from fluxing or melting.
2. Only one recording instrument is used with this system, which may be applied to multiple checker installations. This instrument provides the control functions as well as a complete record of true temperatures taken at the top of the checkers.
3. It operates the regenerative system at the highest practical temperature level consistent with good operating practice and long refractory life.
4. Although the basic system normally initiates reversal when automatically predetermined temperature conditions occur, the addition of the automatic timers prevents unbalancing of the furnace.

The following limitations of this system appear logical for consideration:

1. The actual maximum frequency of reversal (minimum time) during a large portion of the heat when temperature levels in the checkers are low does not appear to take full advantage of these conditions either in stack losses or rate of temperature increases.
2. The advantages to be gained by such a system over those obtained with a relatively simple system of fixed high temperature limit interlocked with minimum and maximum time should be considered when justifying the additional expense involved.
3. Too much emphasis may be placed upon temperatures while checkers are being heated, without regard to preheated air conditions.

Preheat drop reversal system — This system is based upon initiating furnace reversal from a predetermined allowable drop of the preheat temperature. The actual temperature value, which initiates reversal, is automatically set in relation to the maximum preheat temperature available from the same cycle.

The temperature measurements for actuating this system are taken in the hot ends of the checker system, preferably by means of radiation in order to secure an automatic lowering (as explained under the temperature difference system) of allowable preheat drop as the temperature level in the checkers increases toward the finishing stages of the heat.

The fundamental operating principles of this system give greatest weight to the importance of maintaining efficient preheat temperatures on the input side of the furnace under all firing rates and checker conditions, rather than losses on the output side.

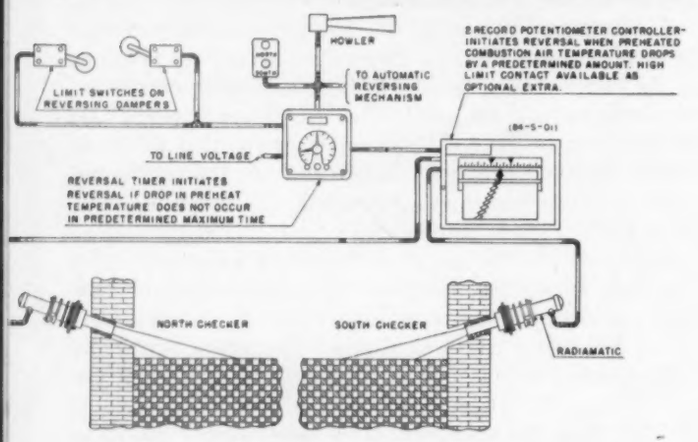

HOWLER
2 RECORD POTENTIOMETER CONTROLLER-INITIATES REVERSAL WHEN PREHEATED COMBUSTION AIR TEMPERATURE DROPS BY A PREDETERMINED AMOUNT. HIGH LIMIT CONTACT AVAILABLE AS OPTIONAL EXTRA.
TO AUTOMATIC REVERSING MECHANISM
LIMIT SWITCHES ON REVERSING DAMPERS
TO LINE VOLTAGE
REVERSAL TIMER INITIATES REVERSAL IF DROP IN PREHEAT TEMPERATURE DOES NOT OCCUR IN PREDETERMINED MAXIMUM TIME
NORTH CHECKER
SOUTH CHECKER
RADIAMATIC

Figure 12 — Preheat drop system of reversal control, interlocked with maximum time control.

Referring to Figure 12, the system consists essentially of two temperature responsive elements (one for each checker) which are connected to a two-point potentiometer which records the temperature of each checker. This instrument has a control table of adjustable width which is automatically raised or lowered in response to temperature conditions. The width of the control table is shown by the setting of the two control indexes.

Reversal is initiated when the descending temperature of the cooling checker reaches the low index. An automatic timer is interlocked in the system so that reversal will occur in a maximum time if temperature conditions do not call for reversal, such as may occur during charging, delays, etc. Movement of the control table is responsive to temperature of the heating and cooling checkers in relation to both control indexes. Thus, the temperature at which reversal occurs is variable and is always in pace with the ability of the regenerators to supply preheat.

The rate of movement for the control point drive, although fast enough to keep up with the increase in average checker temperature throughout a heat, is slow enough that when an unbalance occurs, readjustment of the minimum temperature control point establishes balance between the checkers over a period of several reversal cycles.

Changes in the rate of heating the outgoing checker caused by door openings or lower fuel input caused by furnace temperature control, do not lengthen the reversal period of that cycle (as is caused by temperature difference or maximum temperature methods) but establishes a shorter cycle for the following reversal, thus taking full advantage of the available heat supply from each checker. Lengthening of subsequent cycles are similarly produced by periods of lime or ore boils, hot metal additions, etc.

Since true temperatures of the hot ends of checkers are being measured, the initiation of reversal can also be actuated from a high temperature limit on the checker being heated.

A summary of the operating advantages of this system includes the following:

1. Maintains an efficient preheat temperature, hence the greatest stability of temperature, length of flame, and maintenance of effective working heat head above the metal bath.
2. Protects refractories by reversal from a maximum temperature limit, which is detected very rapidly from a measurement of higher temperature conditions.
3. Balances the checker system on a basis of minimum available temperatures rather than average heating and cooling conditions or maximum temperature conditions.
4. Rebalances any non-uniformity over a period of several reversal cycles rather than attempting to secure balance on each cycle.
5. Inherently reduces frequency of reversal periods at low checker temperatures, while working heat heads are easily maintained in the furnace, thus reducing the losses caused by reversal in order to increase checker temperatures. Reversal frequency is increased as furnace and bath temperature increases demanding maintenance of the highest available heat head, as losses in waste gases increase, and as maximum allowable refractory temperatures are reached.
6. Establishes the firing period for each checker upon the ability of that checker to deliver heat rather than anticipating the heating ability of the opposite checker.
7. Simplicity — A single instrument provides independent records of the temperature of each checker as well as a control circuit based on the descending temperature of the firing checker.

TIME VS TEMPERATURE METHODS OF REVERSAL

At first, all regenerative furnaces were reversed on a time basis. The time chosen was, in the operator's judgment, the best average for highest operating efficiency. Where fuel rates are constant, normal balancing undisturbed by furnace operations, and preheat or refractory limitations not severe, a reversal system based upon time is simple, inexpensive and adequate. Whenever these factors vary or have increased importance, then the additional value of reversal from some temperature condition becomes apparent.

Additional factors which influence checker balance and operating efficiency, but which are not adequately handled by a time system include:

1. Where fuel rates vary, it is evident that the lower the fuel volume or heat input to the furnace the slower the rates of temperature change in the checker system.
2. The progressive change in heat capacity or rate of heat absorption and discharge of the checker brick with age.

3. In some cases when new checkers are constructed, the two sets show radically different heat capacities.
4. Where fuel rates are automatically controlled from a furnace condition, such as roof temperature control, and the furnace is unbalanced at the time of reaching the fuel reduction period, the decrease in fuel caused by high furnace temperature will cause a further reduction in temperature of the "cold" checker and so continue or further the unbalance of a furnace which is reversed entirely on a time basis.

In the case of high temperature batch type furnaces such as the open hearth, it follows that for optimum control of air preheat temperatures, the reversal period should be varied to meet the changing conditions in the furnace system. These requirements are more closely approached when reversal is based primarily on measurements of temperature rather than an arbitrary measure of time. Generally, more satisfactory results are obtained on an open hearth furnace when temperature measurements are interlocked with automatic timers.

Regardless of whether the system is signaling or fully automatic, it is to be noted that where temperature conditions are used to initiate reversal, it is possible and often desirable to interlock automatic timers as an integral part of the system. These timers may be used in numerous ways; for example, a lock-out timer may be used to prevent reversal regardless of temperature conditions until some predetermined time has elapsed. Conversely, or in the same system, a reversing timer may be interlocked so as to initiate reversal regardless of temperature conditions after some predetermined maximum time has elapsed.

In addition, where differential temperature methods are employed, additional limiting functions may be interlocked in the system to initiate reversal on either high or low checker temperature regardless of temperature difference between them.

THE PROPER SYSTEM FOR A GIVEN FURNACE

Now that the principal factors of regenerator operation and the inherent characteristics have been discussed, the selection of the most desirable system for a given application is a question of determining the order of relative importance of the principal operating factors (Table I) and of selecting the simplest system which will maintain these factors at or near the optimum level.

Continuous reheating furnaces — On the reheating furnaces where the exit gas loss is relatively more important than the loss of preheat and the losses during reversal are not a serious factor, automatic timer control is frequently sufficient. If the reversal is based upon the temperature of exit gases, reversal periods will be automatically lengthened during mill delays or holding periods at which time the fuel input to the furnace is reduced. This is in keeping with established practice.

Usually, the maximum temperatures applied to the top checker brick are not a serious factor although if the materials or construction used make this an important maintenance problem, the measurement and control of this temperature condition can be added to the system so as to limit the maximum time between reversals.

Batch reheating furnaces — With this type of furnace as exemplified by the soaking pit, there is a very wide range of fuel rate from a maximum with low checker temperatures during the heating period to a minimum with high checker temperatures at the end of the soak-out.

The high firing rates during the heating period cause a rapid drop in air preheat temperature as well as an increase in exit gas temperature. During this period, however, the temperature level in the checker system is low; therefore, the exit gas losses are relatively unimportant, nor is the maximum preheat necessary to maintain a satisfactory temperature head in the furnace above that of the product. Actually, too high a temperature level during this stage of heating may be detrimental to the product and result in "washed" ingots. The final stages of soaking may greatly reduce the fuel rate which usually decreases the loss of both preheat and exit temperature. Under these conditions of operation, time may be used as the sole basis of initiating reversals throughout the entire heating and soaking cycle.

Where it is necessary for the fuel to be shut off during drawing operations, especially on rapid drawing cycles, it becomes necessary to regain as quickly as possible the heat which was lost when the cover was off. This means that a high fuel rate must be introduced to the furnace when the regenerator system is at its highest temperature level.

Under these conditions, it is desirable to increase the reversal frequency so as to regain the lost heat and maintain uniform temperatures throughout the entire furnace system. This is readily accomplished by augmenting the time reversal system with a temperature controller, which will cause reversal when desired maximum checker temperatures exist.

Batch type melting and refining furnaces — On a batch type high temperature furnace many factors important to economical operation must be considered. Of first order importance is preheat temperature because if the maximum possible preheat temperature consistent with good refractory life is not available, the maintenance of high temperature levels necessary for economical operation will not be attained.

TABLE II

SUMMARY OF OPERATING CHARACTERISTICS VARIOUS SYSTEMS

REVERSAL CHARACTERISTICS		DIFFERENTIAL TEMPERATURE FROM THERMOCOUPLES	DIFFERENTIAL TEMPERATURE FROM RADIATION + MAXIMUM TEMP. + MAX. TIME	FLOATING TEMP. + MAXIMUM LIMIT + MAX. & MIN. TIME	TEMPERATURE DROP + HIGH LIMIT + MAXIMUM TIME
THERMAL BALANCE BASED ON	WASTE GAS TEMPERATURE	X			
	AVERAGE OF MINIMUM PREHEAT-MAXIMUM REFRACTORY TEMPERATURE		X		
	MAX REFRACTORY TEMPERATURE			X	
	MINIMUM PREHEAT TEMPERATURE				X
REBALANCE ON EACH REVERSAL		X	X	X	
REBALANCE OVER SERIES OF REVERSALS					X
LONG REVERSAL PERIODS AT LOW HEAT LEVELS			X		X
SHORT REVERSAL PERIODS AT LOW HEAT LEVELS				X	
APPROXIMATE EQUAL REVERSAL PERIODS AT ALL HEAT LEVELS		X			
REVERSAL FROM MAXIMUM REFRACTORY TEMPERATURE			X	X	X
DECREASE REVERSAL FREQUENCY AT HIGH TEMPERATURE LEVEL				X	
INCREASE REVERSAL FREQUENCY AT HIGH TEMPERATURE LEVEL			X	X	X
FURNACE CHANGES EFFECT LENGTH OF CURRENT CYCLE		X	X	X	
FURNACE CHANGES EFFECT LENGTH OF FOLLOWING CYCLE					X

As has been previously pointed out in the consideration of batch type reheating furnaces, the losses in preheat air and exit gas temperatures at low temperature levels are relatively unimportant, thus permitting a relatively long firing period with accompanying small losses due to furnace reversal. However, as maximum temperatures are reached during the finishing stages of the heat, the emphasis shifts to the minimum preheat loss and maximum permissible top checker temperatures.

Although the importance of exit gas loss is minor by comparison to fuel rate and is usually taken care of by properly sized checker chambers or waste heat recovery units, any automatic shortening of the firing periods during the final stages of the heat tends to keep these losses at their proper low level.

Based upon consideration of these factors it is obvious that open hearth reversal should be based upon a measurement of temperature conditions in the hottest part of the regenerator. Only then is it possible to control from preheat temperatures and to prevent excessive checker brick temperatures. The four systems which were briefly described cause reversal from temperature measurements. As was pointed out in the brief discussion of each system, all possess inherent advantages and disadvantages when considered from the standpoint of controlling each factor of furnace operation to optimum value.

TABLE III

TABULATION SHOWING THE CONDITIONS UNDER WHICH REVERSAL OCCURS WITH VARIOUS CONTROL SYSTEMS

CONDITIONS UNDER WHICH REVERSAL OCCURS.	AUTO. TIME REVERSAL (FIG. 83-S-98)	"TEMPERATURE-DIFFERENCE" SYSTEM FROM COUPLES (FIG. 83-S-98)	"TEMPERATURE-DIFFERENCE" SYSTEM FROM RADIAMATICS (FIG. 84-S-00)	"TIME-MAXIMUM TEMPERATURE" SYSTEM	PREHEAT DROP METHOD (FIG. 84-S-01)
WHEN OUTGOING CHECKER TEMPERATURE REACHES A MANUALLY PREFIXED MAXIMUM VALUE			X	X	X
WHEN MAXIMUM TIME HAS ELAPSED	X		X	X	X
WHEN CHECKER TEMPERATURE DIFFERENCE ATTAINS A MANUALLY PREFIXED VALUE		X			
WHEN CHECKER TEMPERATURE DIFFERENCE REACHES A MANUALLY PREFIXED VALUE WHICH AUTOMATICALLY DECREASES AS TEMPERATURE LEVELS INCREASE			X		
WHEN INCOMING CHECKER TEMPERATURE DROPS A MANUALLY PREFIXED AMOUNT, WHICH AUTOMATICALLY DECREASES AS TEMPERATURE LEVELS INCREASE					X
WHEN OUTGOING CHECKER REACHES AN AUTOMATICALLY INCREASED MAXIMUM TEMPERATURE				X	

Tables II and III will facilitate ready comparison of the major operating characteristics of the reversal systems set forth, and will assist in the selection of the method best suited to the individual furnace design, method of operation, possible speed of reversal operation and principal objectives desired. The use of any of these systems, whether signaling or fully automatic, will result in more uniform operating conditions and an increase in furnace output as well as decrease in the cost of furnace and checker refractories.

This discussion has made no attempt to cover checker design and has only briefly touched upon the question of methods and sequences desirable in securing the most rapid and efficient procedure in performing the actual reversal operation. However, from the standpoint of thermal conditions and thermal balance, these comments may be of assistance in selecting a method for the initiation of regenerative furnace reversals.

DISCUSSION

PRESENTED BY

E. E. CALLINAN, Combustion and Refractory Engineer, Steel and Tube Division, Timken Roller Bearing Company, Canton, Ohio

J. R. GREEN, Manager of Steel and Ceramic Division, The Brown Instrument Company, Pittsburgh, Pennsylvania

E. C. McDONALD, Combustion Engineer, Republic Steel Corporation, Cleveland, Ohio

M. J. BRADLEY, Market Extension Division, Leeds and Northrup Company, Philadelphia, Pennsylvania

C. T. SCHORR, Assistant Power and Fuel Engineer, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania

E. E. Callinan: In the temperature drop method I did not understand why complete correction was not reestablished on the following reversal. Why is correction not completed until after a series of reversals?

J. R. Green: Reversal by the preheat drop system is actuated, except under conditions of maximum allowable checker temperatures, from a decreasing temperature condition in the checker which is delivering preheated air. Therefore, door openings or bath reactions which effect only the heating checker do not influence the time of the current cycle as they do with temperature differential or maximum temperature systems.

The temperature setting which initiates reversal in this system is automatically established by the maximum preheat temperature available at the beginning of each cycle. The rate of this automatic adjustment is fast enough to keep pace with the changes in average checker temperature as the heat progresses or is tapped. In order to assist the natural rebalancing of the furnace, the rate is slow enough that several cycles may be required to completely reestablish balanced conditions after a radical upset.

E. C. McDonald: The only types of reversal I have had any experience with have been reversal from time, both automatic and manual, and temperature differences from thermocouples in flues. I prefer the reversal from thermocouple in flues and it does not have to be automatic. I recognize that the instrument does not record the temperatures of the checker brick nor the temperature of the incoming air, but it does give a good indication of the kind of a job of balancing the furnace operator is doing, especially on a manually operated furnace.

On an automatic installation the operator has full control of his furnace. He can increase or decrease the temperature difference setting, and by doing so he can increase or decrease the reversal intervals. I feel this system is hard to improve upon unless you get into some of the complicated radiation types Mr. Green has discussed.

My experience on radiation pyrometer installations shows they require a daily checkup to insure accuracy.

On the other hand thermocouples can go several weeks in the flues without attention. This is very important with a shortage of manpower as at present.

From an instrument standpoint, though, I think Mr. Green is warranted in bringing out all the features and schemes, and possibly in the future all furnaces will be equipped with instruments showing the exact temperature at every point and some other equipment to do something about it.

M. J. Bradley: Mr. Green has presented a lot of information on the problem of reversing regenerative furnaces of different types. My remarks are confined principally to open hearth furnaces which include the fundamentals underlying all types and use them under more severe conditions.

The information presented appears to justify the following statements.

1. The main reason for using the regenerative furnace is to preheat the air used in combustion in order to obtain the desired flame temperature and characteristics and to obtain better fuel efficiency.
2. The heating up end and the cooling down end of the furnace must be reversed periodically in order to maintain the preheat cycle within efficient temperature limits.
3. The interval between reversals should be based on the temperature conditions within the furnace system itself, including both the heating up and cooling down cycles.
4. The method of reversing should keep the furnace system in temperature balance and encourage the gradual building up of the heat head in the checker system from charging to tap.

Statements 1 and 2 indicate why the regenerative furnace is used and why it is reversed, while 3 and 4 indicate the fundamentals for the method which should be used in reversing.

There are two schools of thought on the method of reversing a regenerative furnace:

1. The time method.
2. The temperature method.

The time method started with the open hearth development long before practical means were available for measuring temperatures. It is still used on the majority of regenerative furnaces. On regenerative furnaces used in continuous operation (glass melting tanks) the intervals between reversals are based on a constant time period. On regenerative furnaces used in batch operations (open hearth furnaces), although based on constant time, the periods are usually varied over wide limits in order to keep the furnace within temperature balance and to take care of operating irregularities. Fundamentally, the temperature considerations, in a great degree, determine the intervals between reversals.

The temperature method was introduced in the late 20's when only thermocouples were available for measuring the temperatures. The thermocouples were usually installed to measure the temperatures in the outlet flues close to the regenerators because of maintenance considerations and also because all the hot waste gases leaving the furnace system must pass through this restricted area. This location, therefore, provided an average overall measurement.

The radiation method of measuring temperatures has been improved greatly during the last ten years and due to the characteristics of these temperature measuring devices, they have proven ideal for measuring the higher temperatures in the open hearth furnace system. When properly installed, they are much more permanent, more rapid in response, and require less maintenance than thermocouples.

A study of the methods used for reversing the regenerative furnace as outlined in the paper (if divorced for the moment from the methods and means of measuring temperatures) seems to indicate that the temperature difference method is the only method which is based entirely on temperature. By taking into consideration both the heating up and cooling down cycles, it maintains the furnace system in temperature balance and automatically corrects for operating irregularities. It insures that the furnace will not remain on one end too long while heating up at the expense of over cooling the other end. Thus, it encourages the gradual building up of the heat head. If the most efficient temperature difference is being used, there is little to be gained — possibly more to be lost — by reversing the furnace before the temperature difference has been reached, regardless of variation in the time interval between reversals, which may or may not vary in keeping the furnace in balance.

Fundamentally, the temperature difference method combines both schools of thought, namely, time and temperature. Some of the limitations listed for this method may be charged to the shortcomings in the furnace structure over which the method of reversing has no control except possibly to indicate that something is wrong.

The paper throws considerable light on the main issues involved, which are how and where to measure the temperatures best suited to determine the most efficient time interval between reversals, and how to use these temperatures to initiate the better method for reversal.

The actual temperatures in the hot end of the checker chamber and in the flues follow similar cycles, but at different levels and rates of response. In either location, the temperature measured may be considered an average spot temperature measurement. However, the measurement of the higher temperatures in the hot end of the checker chamber or in the fan-tail arches are much nearer to the furnace bath and combustion areas, which is of first importance. This might indicate that the radiation type of temperature measuring unit meets the requirements better. Fortunately, radiation pyrometers have characteristics ideally suited for this application.

The main difficulty has been to adapt the radiation pyrometer, with its fourth power characteristic, in combination with instruments developed for uniform, straight-line scale characteristics. The two methods outlined for using radiation pyrometers appear to be attempts to overcome this difficulty. The radiation pyrometers can measure the temperatures involved satisfactorily, while variable timers, relays, mechanical shifting of the control table, and other accessories have been added in order to obtain results somewhat approaching the temperature difference method which depends upon temperature changes only. Recently this problem has been solved without the necessity of using

(*Please turn to page 81*)

NEW *Seamless Tube Mill*

FOR PITTSBURGH STEEL

. . . . built with minimum interruption of operations of the old mill which it replaced, this new mill is designed to produce tubes 2⅞-7⅝ in. outside diameter . . . .

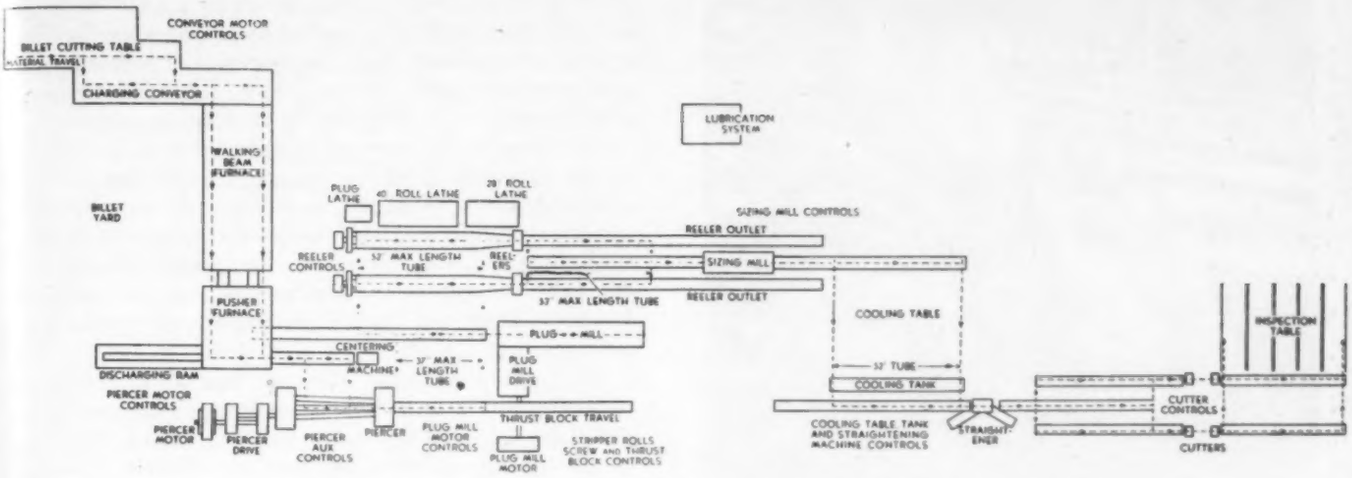
▲ WITH the unleashing of some 30,000 horse-power of energy in its motors and furnaces, the new seamless steel tube mill of the Pittsburgh Steel Company went into production recently at Allenport, Pennsylvania.

The new mill replaces an older mill which was installed in the same building in February 1921, and that has been in operation since that time until its recent removal to make way for the new mill. In fact, installation of the new and larger mill on the site of the old mill, at the same time maintaining production on the old mill as long as possible because of the urgent need for seamless tubes, presented special problems which called for great ingenuity upon the part of the engineering staffs directing the new construction and installation. A part of the new mill was built literally on top of the old mill with the old mill still in operation.

The new billet heating furnaces, together with billet cutting tables, charging conveyors and discharge mechanisms, were completed several months ago. One Saturday night early in October, the evening shift completed its turn, piercing and rolling billets taken from the old furnace at midnight. Construction crews went to work, tore out the old system for conveying heated billets from the old furnace to the piercer, installed special temporary conveying system for transferring heated billets from the new furnaces to the old piercing mill and on Tuesday, about 60 hours later, the old mill was again in full operation with billets coming from the new heating furnaces.

Immediately razing operations began on the old furnace, which was the site for the new piercing mill and its drive equipment, followed by the necessary excavating, building of concrete foundations, and installation of the new piercing mill, motor and driving-gear mechanisms. In this manner construction and installation

Initial heating is performed in this 25 ft x 60 ft walking beam furnace, following which a 25 ft x 24 ft sloping hearth furnace finishes the heating.



Plan showing general arrangement of new seamless tube mill.

of the new mill was carried forward with the old mill still in full production until November 20, 1944 when its operation had to be abandoned to make way for further installation of the new mill.

In the short space of ten weeks, units of the old mill including the rolling mill, reelers, sizing mills, cooling table, and cut-off machines were removed, extensive excavating operations completed, forms built, foundations poured, and corresponding units of the new mill installed and readied for production.

The new mill, which is very heavily built and weighs about four times as much as the replaced mill, is designed to roll tubes in sizes from 2⅞ in. to 7⅝ in. outside diameter in a wide range of wall thicknesses and lengths. Its design and layout permit straight line, high speed production, and its heavy operating parts mounted in extra heavy anti-friction bearings make possible the rolling of material to much more exact dimensions and also the handling of many types of special alloy steels which are difficult to handle on older type mills.

The overall operation of the new seamless tube mill is to convert solid round steel billets or tube rounds into finished hot rolled seamless steel tubes. The billets are produced at the company's steel plant at Monessen, Pennsylvania, and are delivered to the Allenport plant, a few miles up the Monongahela River, usually by river barge. In the billet yard at the Allenport plant, the billets are peeled by rotary cutters which take off sufficient stock to remove surface imperfections. Next the billets, which vary in diameter from 3 in. to 7 in., are cut to lengths of from 3 ft to 19 ft (depending upon the amount of stock required for the dimensions of the finished tube) and pass by charging conveyor to the heating furnaces.

The billets, preparatory to piercing, are heated in two large furnaces fired by natural gas or fuel oil. In the first furnace, where their temperature is raised to 1500 F, the billets rest on horizontal skids and are moved through the furnace by walking beams which lift all of the billets simultaneously, advance them from 6 in. to 12 in. at each "step", and return them to the skids. The length of travel at each step is adjusted in accordance with the size of the material and the heating time necessary. This furnace is 25 ft wide x 60 ft long.

The partially heated billets, leaving the first furnace, are automatically transferred to the second furnace where they are raised to the proper piercing temperature. In this higher temperature furnace, where it would be impractical to continue the walking beam mechanism, the hearth slopes downward toward the discharge end and the billets are pushed forward down the sloping water-cooled skids. This furnace is 25 ft wide x 24 ft long, and is of side-discharge type.

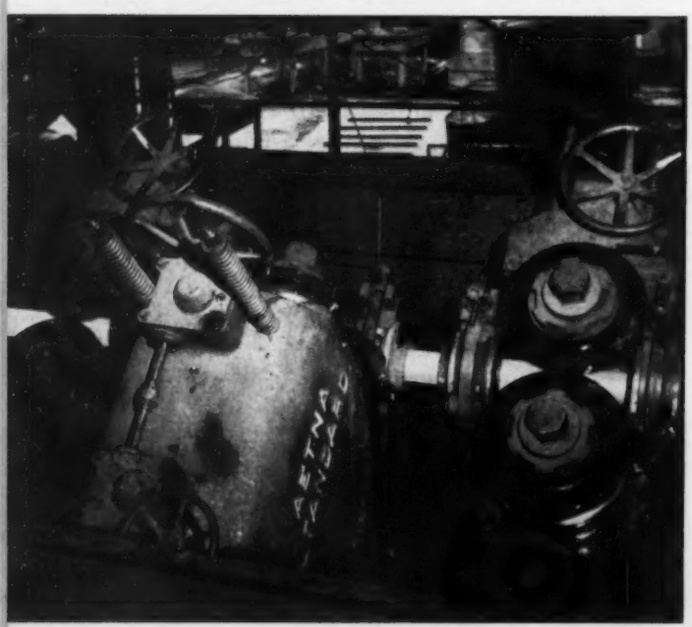
The entire movement of the billets from the charging

The piercing unit is driven by a 4000-2000 hp, 514-257 rpm synchronous motor. Piercer speed is varied by a selection of motor speeds and gear-box gears.

In the plug mill, which is driven by an 1800 hp motor, the tube is rolled out and lengthened.

▲

The sizing mill has several unusual features, with overhanging rolls and roller bearings. Rolls may be changed without disturbing bearings.



conveyor through both furnaces to the discharge trough is automatic, and timing of the cycle for all mechanisms is controlled by a central control unit. At the same time a manual control enables the operator to make any modification in the cycle necessary in delivering heated billets to the piercer.

Following this heating operation, which requires from one and one-half to three hours, a ram discharges a billet to a run-out table beside the piercer. On this run-out table, the forward end of each billet is centered to facilitate concentric piercing. Centering is performed by an air hammer which punches a centering hole about 1 in. in diameter and about 1½ in. deep.

The heated billet promptly enters the piercer where the billet is pierced by the process known as Mannesman roll piercing, which employs both diagonal rolling and piercing. The piercing unit is driven by a 4,000-2000 hp, 514-257 rpm, 6600 volt synchronous motor and several speeds are available from the selection of motor speeds and gear-box gears. The motor is completely enclosed and is cooled by a recirculating ventilating system.

Upon leaving the piercing mill the tube moves directly to the tube rolling mill or plug mill where the tube, in repeated passes through this mill successively between the grooved rolls and over successive mandrels, has the wall thickness and diameters reduced as desired, and the tube is proportionately lengthened. An 1800 hp, 150 rpm, 2200 volt synchronous motor drives the plug mill.

After completing the plugging operation the tubes pass alternately to the two reelers which are driven by a 350 hp, 375-750 rpm, 230 volt d-c motor. Here the tube, still hot, is forced between two swiftly revolving rolls and over a mandrel plug held in the tube between the rolls, the rolls being slightly inclined to give forward motion to the tube. The reeling operation makes the tube round, practically straight, and gives it a burnished surface.

From the reelers the tube passes through a 5-stand sizing mill which completes the rolling operation by reducing the diameter of the tubes to the desired finished dimensions. This is the first large-size tube sizing mill built with overhanging rolls and also with roller bearings. The long, oversize roll shafts operating in roller bearings result in a new standard of accuracy. More-

After cooling, the tube is passed through a six-roll straightening machine of modern design.

over, the equipment is of special design which permits changing of rolls without disturbing the bearings. This unit is driven by a 75 hp, 850-1750 rpm, 230 volt d-c motor.

With the hot rolling operations completed, tubes pass to the cooling table where their temperature is permitted to drop below the critical point, and as they leave the rear end of the cooling table they drop into a cooling tank. From this tank the tubes pass through a modern 6-roll straightening machine, in which guides are eliminated, where the tubes are straightened for their full length.

From the straightener the tubes move to the cut-off machines where the crop ends are removed. These cut-off machines, with four cropping units, have outstanding features of design and operation developed largely by Pittsburgh Steel Company engineers. The tube is held stationary and the cutting head rotates. The four cutting heads actually are mounted in tandem pairs in one large compact unit. The forward end of the tube enters the first cutting head of a pair, this end is cropped, the cutters retract and the tube passes on through the first cutting head and through the second cutting head in the pair up to the position where the rear end of that tube is to be cropped. With the compact arrangement of the four cutting heads and with the controls all centrally located the four units are operated in unison, cropping four ends almost simultaneously. From the cut-off machines the tubes pass directly to the inspection tables for final inspection. They are then ready for shipment as hot finished tubes, or if required go to the cold-draw, specialty or other departments for further operations.

A central circulating oil system is used to lubricate the main driving mechanisms of the entire mill. All returning oil is cleaned as it passes through the central unit, and the oil is heated as required according to weather conditions.

An outstanding feature of the design and operation of this new mill is the speed with which the tubes reach inspection. This operates as a continuous and early check on all production line operations. If at any time inspection standards are not being met, the departure can be corrected promptly and with a minimum number of improperly made tubes on the line.

At the present time, all the production of this new tube mill is being supplied on priorities for highly essential war needs. Later when these requirements are reduced, the mill will be used for the manufacture of seamless steel tubes in a wide range of sizes in many carbon, alloy and stainless analyses for users who require high quality tubing, and also it will be in a position to furnish tubing rolled to close tolerances on special specifications.

Green and Vollrath DISCUSSION

(*Continued from page 77*)

complicated accessories, and radiation pyrometers are being used directly to initiate the temperature difference method of reversal. The temperatures are being measured within the fan-tail arches before the hot gases reach the checker chamber and just as the preheated air leaves the checker chamber on its way for combustion within the furnace.

The proper method of reversing a regenerative furnace and its operation, whether manual or automatic, warrants more consideration than the initial cost of the equipment involved. More efficient methods and sequences in reversing regenerative furnaces may return many times the initial investment for the equipment.

C. T. Schorr: Mr. Green and Mr. Bradley brought out the apparent disadvantages of the two established methods of temperature detection.

The thermocouple in the exit end of the checker naturally does not protect the hot end of the checker from excessive heat carryover, and radiation pyrometers in the high end of the checker would tend to give us premature reversal in case we used that.

I would like to ask Mr. Green whether a combination of the two could not be worked out in such a way as to give us a better overall temperature of the checker to be used as an index for our automatic reversal.

J. R. Green: With reference to a system combining both thermocouples in the outgoing flues and radiation measurement on the hot ends of the checkers, such a combination was installed a number of years ago in the glass industry with mediocre success. Better results are being secured from a simpler system of hot end measurements by means of radiation.

The success of measuring temperatures in the hot end of the checkers is fundamentally dependent on the improvements made in design and construction of radiation types of measurement. Very satisfactory operation and low maintenance can now be secured with this type of equipment. Actually, when the equipment is properly installed, there is very little need to worry about carryover calling for a premature reversal. An indication of this condition is only dangerous when the maximum allowable temperature has been exceeded, and something should be done about it at that time.

The addition of maximum timers to any system, regardless of principle of operation and whether based upon thermocouples or radiation measurement, should be considered as a simple safeguard obtainable at small additional cost.

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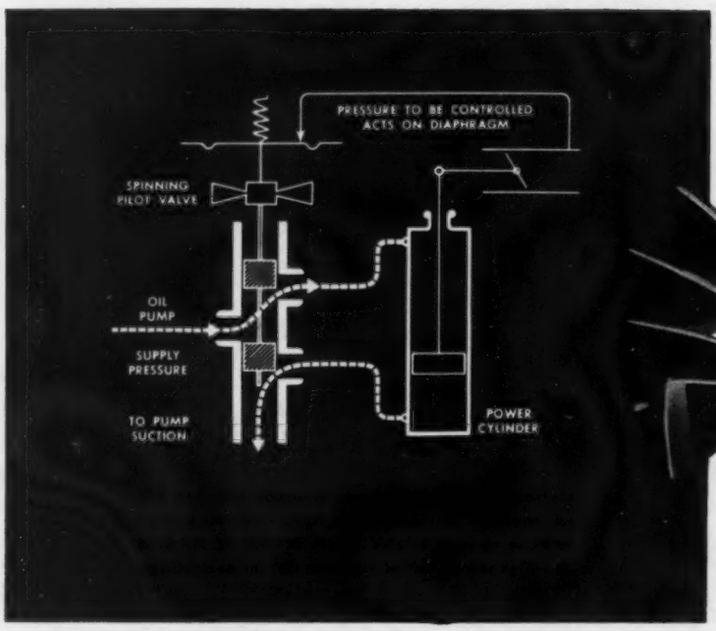

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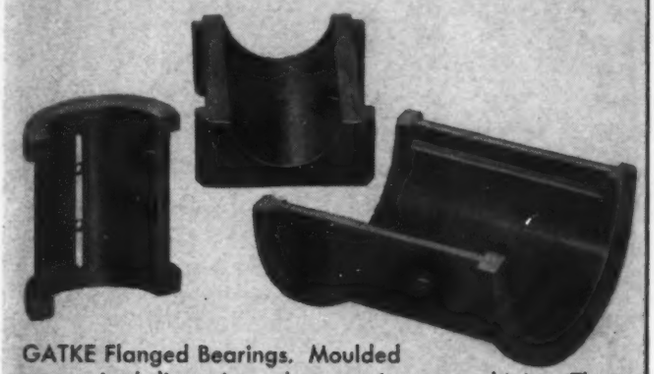

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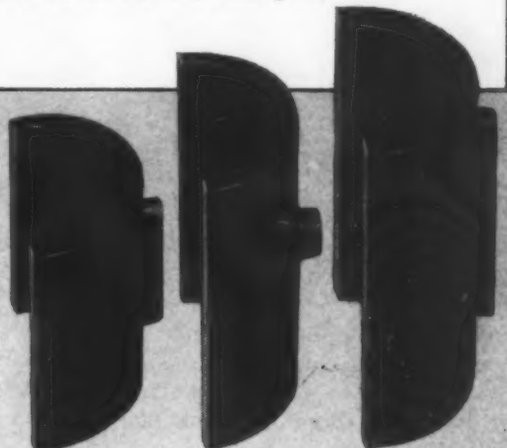
GATKE Genuine Moulded Split Bushing used on Rudders of large ships. Size 16" O.D. by 11" long.

Half sphere moulded by GATKE (12" diameter). Even irregular shapes are moulded to close tolerances affording proper contours with smooth, wear resistant surface that requires no machining and no finishing.

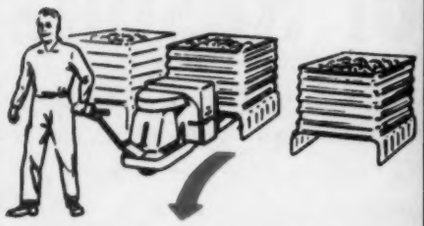


Eccentrically shaped half bearings. GATKE Moulding Processes effect important economies in the production of eccentric and other irregular shapes.
Literature on request.

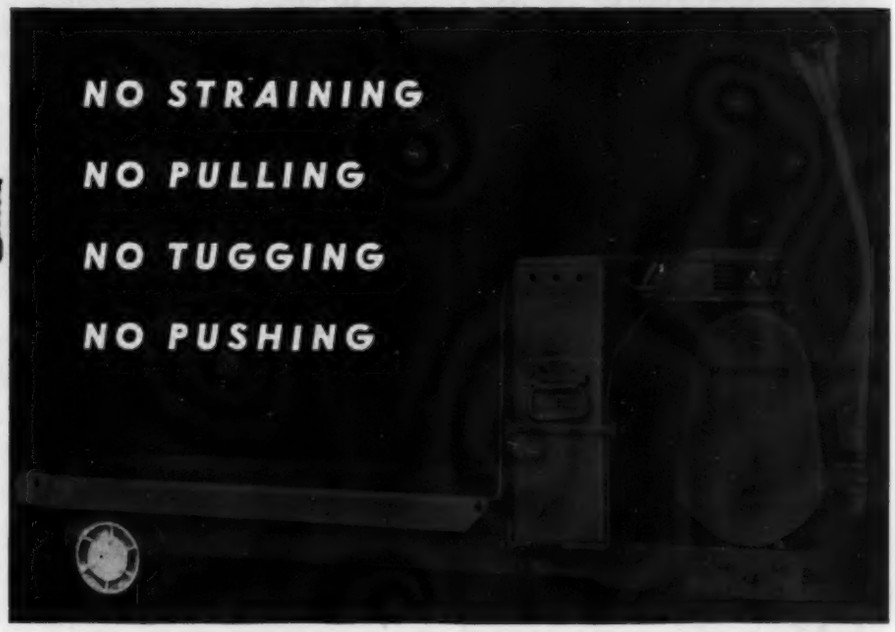
Climaxing 30 years' Progress in making things to do the Job BETTER

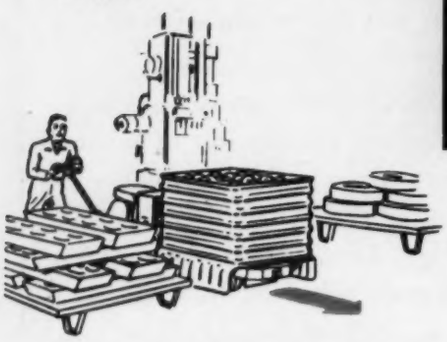
Tons transported all along the production line speedily and only - - - - - - -

ONE TRUCKER NEEDED



STEP I—Skid loads from production are quickly dispatched using one man or woman with "TRANSPORTER."

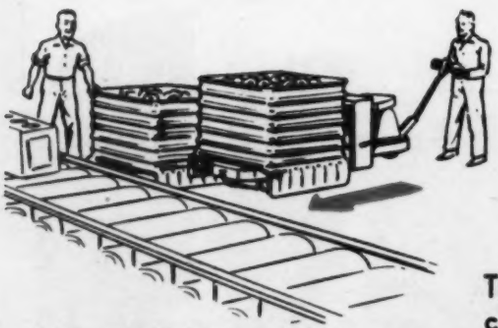




STEP II—Assembly machines 10 to 25 feet apart are easily served by using "TRANSPORTER." Narrow aisles can be readily maneuvered.

TRANSPORTER
PLATFORM LIFT TRUCKS

★ **Results: Reports show 100 to 500 tons of material per day can be easily handled and dispatched by using one man or woman with "TRANSPORTER."**



STEP III—Finished products are quickly moved from assembly to final packing marking and strapping line with "TRANSPORTER" operations.

The "TRANSPORTER" is easy and safe to operate with thumb tip controls in steering handle for safe walking speeds. Electric motor is powered by heavy duty battery and mechanically drives front wheel at any steering angle. Brake is mechanical and positive with automatic emergency control. Lift has shockless hydraulic operation with easy foot lever controls.

This lift truck is designed to serve all industry for economical and safe lifting—spotting, and short hauling of various loads of raw materials and finished products on skid platforms up to 6000 lbs. and on pallets up to 4000 lbs.

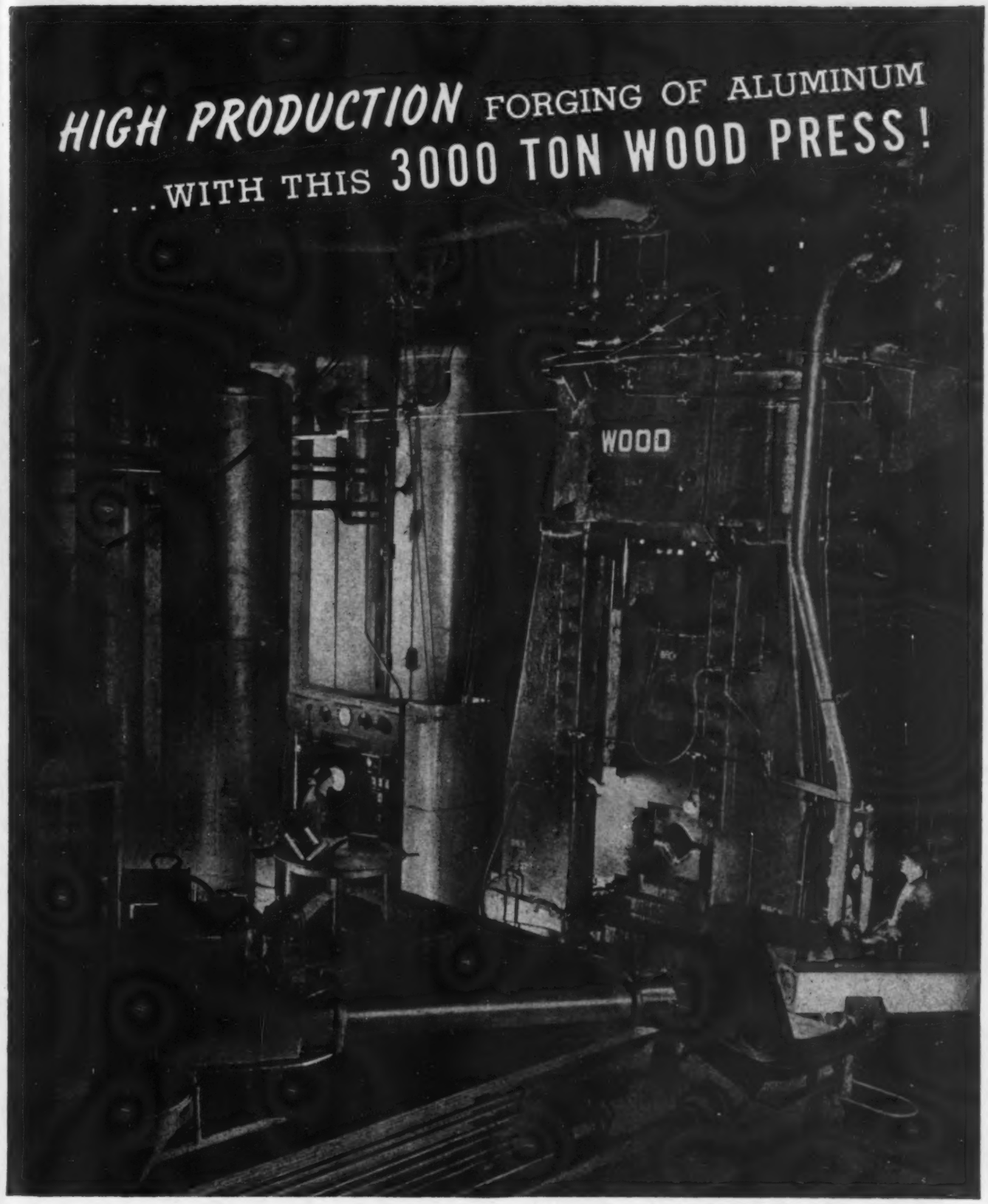
Write for Bulletin No. 8

MANUFACTURERS FOR OVER 38 YEARS *Electric Propelled* INDUSTRIAL TRUCKS

ELECTRIC INDUSTRIAL TRUCKS
MEMBER OF ELECTRIC INDUSTRIAL TRUCK ASSN.

AUTOMATIC TRANSPORTATION CO.
47 WEST 87th STREET CHICAGO 20, ILL.
Division of the Yale & Towne Manufacturing Company

HIGH PRODUCTION FORGING OF ALUMINUM ...WITH THIS 3000 TON WOOD PRESS!



Unprecedented production in the new field of aluminum forging has been made possible by this 3000 ton Wood press which recently went into operation at a large midwestern plant. Especially designed and built by Wood engineers to meet exacting requirements, this unit, with its controls and auxiliaries, is but representative of more than half a century of Wood developments in the broad field of hydraulic press application.

Wood engineers are always available for consultation on your hydraulic press problems.

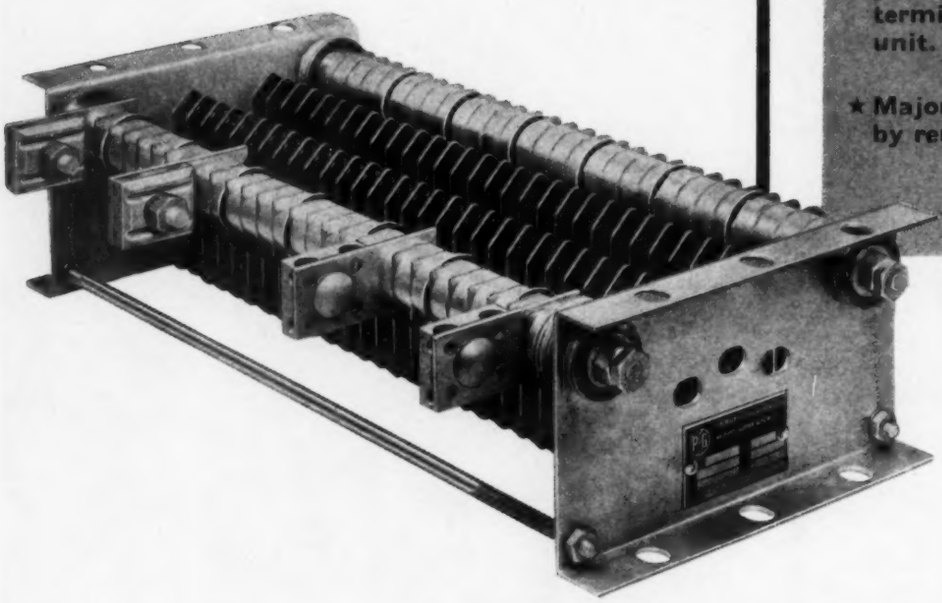
R. D. WOOD COMPANY, PHILADELPHIA 5, PENNSYLVANIA

QUICK CHANGES *are Easy*

with P-G... STANDARD RESISTOR UNITS

Little Effort Required To Make Adjustments

- ★ Minor variations often possible by wire change to other available terminals.
- ★ Greater variations easily produced by movement of terminal position in the unit.
- ★ Major variations effected by removal or addition of one or more standard banks.



Detailed information in BULLETIN No. 500
Copy on request

OPERATING conditions change rapidly today. To meet new production schedules it may be advisable to adjust resistor layouts to do a better and faster job. P-G Standard Resistor Units already in use, and a few spares in the supply room, help in making needed alterations within a minimum time and with utmost efficiency. Normal adjustments can usually be accomplished within a few minutes. For minimum maintenance and maximum production, use P-G . . . . . .

P-G

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO

NEW GRINDER ATTACHMENT *floats* 63-TON ROLLS ON OIL FILM

63 TONS

Two Farrel 60" heavy-duty roll grinders installed in the plant of the Geneva Steel Co. at Provo, Utah, are equipped with hydraulic pressure-relieving devices which actually float the huge 63-ton rolls on oil. By forcing a film of oil between the roll necks and the bearing surface of the neck rests, these attachments reduce the tremendous starting load caused by inertia and friction.

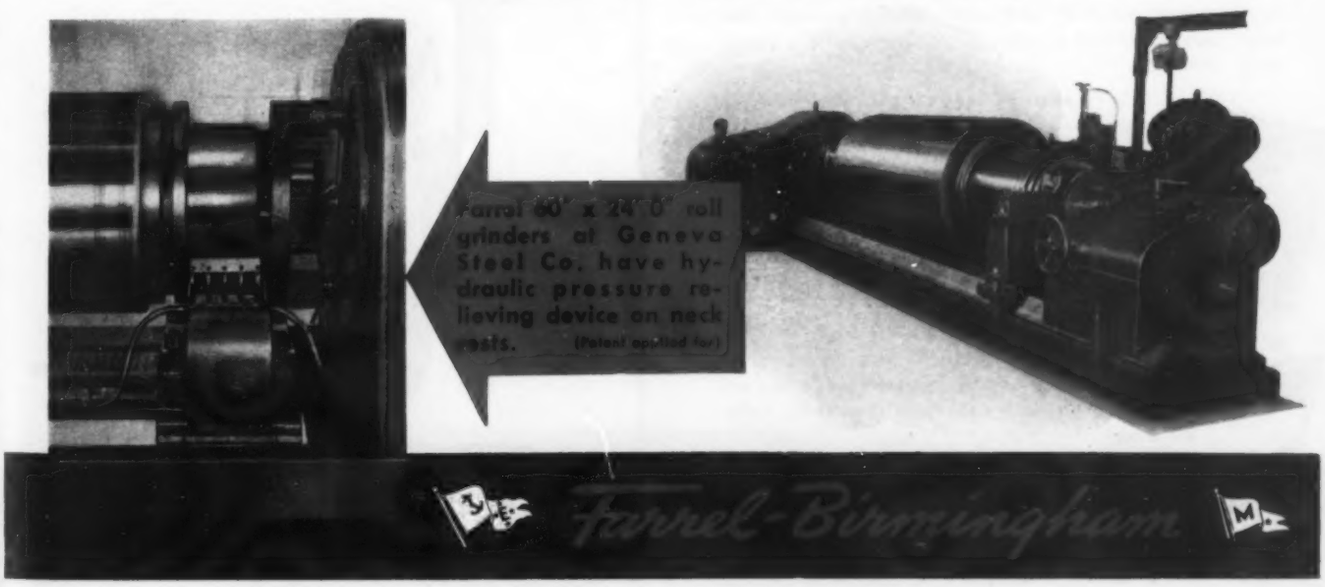
The pressure-relieving device is one of many features which enable Farrel roll grinders to perform extra-heavy duty with maximum efficiency and accuracy and with minimum wear. Here are some of the others:

1. GRINDING WHEEL SPINDLE — Of large diameter for rigidity under working load — made of high grade alloy steel, heat treated and precision ground — mounted in adjustable bearings, automatically lubricated and driven by multiple "V" belts.
2. SMOOTH, VIBRATIONLESS CARRIAGE TRAVERSE—Driven by adjustable, speed-reversing motor through Farrel-Sykes continuous tooth herringbone gear and worm reduction, the smoothest type of mechanical drive known for machine tool carriages.
3. AUTOMATIC CROWNING AND CONCAVING DEVICE—Farrel patented single eccentric type—easily set to produce exact curvature desired.
4. CENTRALIZED CONTROL—Operator can control entire operation of machine without moving from control station at center of carriage—push buttons, rheostats and hand-wheels are within easy reach.
5. INVERTED "V" WAYS — Cast separately from bed of special alloy iron, exceptionally resistant to wear, automatically flood lubricated, covered by flexible metal guards to exclude dirt and grit.
6. SMOOTH HEADSTOCK DRIVE—Faceplate driven by adjustable-speed motor through multiple "V" belts. A self-contained, compact, rugged unit which contributes materially to fine finish.
7. AUTOMATIC LUBRICATION—Grinding wheel spindle, carriage drive and carriage ways are continuously and automatically lubricated to prevent wear of moving parts and preserve initial precision.

Farrel heavy-duty roll grinders finish rolls with high precision and fine finish. They can also be used for grinding heavy cylindrical parts requiring accuracy within close limits. Available in six standard sizes to take maximum diameters of 24", 28", 36", 44", 50" and 60", and any length required between centers.

For complete information write for Bulletin No. 111.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONN.
Plants: Ansonia and Derby, Conn., Buffalo, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Pittsburgh, Akron, Los Angeles


Farrel 60" x 24'-0" roll grinders at Geneva Steel Co. have hydraulic pressure relieving device on neck rests. (Patent applied for)
Farrel-Birmingham

LAMSON Tubes Speed Production

for

KAISER COMPANY, INC.
Iron and Steel Division
FONTANA, CALIFORNIA

Furnace man inserting a test sample of steel in the carrier.

Dispatching the carrier with the test sample to the laboratory.

Analysis-control of steel in process is vital to the manufacture of Open Hearth Steel! Carrying 6 lb. ingots of red hot steel from furnace to laboratory—a four minute trip for a messenger—is now accomplished by Lamson Tubes in only 50 seconds!

● The name KAISER is associated with production miracles! Yet — there are no production miracles — only scientific employment of time-saving, labor-saving equipment will speed up production to the maximum of a plant's capacity. In employing Lamson Tubes to rush ingots of red hot steel from furnaces to laboratory, the KAISER COMPANY, Inc. accomplishes several advances over the messenger delivery system.

★ **SAVES TIME** — The Lamson Tubes require only 50 seconds to cover a distance that takes a messenger 4 minutes!

★ **INSURES QUALITY** — Making steel to a close specification demands constant and rapid quality-analysis. The faster Lamson method is insurance of closer, more accurate quality-control!

★ **IMPROVES SERVICE** — With several furnaces to be served, only this ever-ready mechanical service can assure instant attention to each furnace!

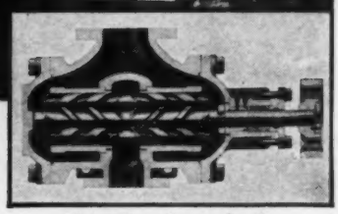
★ **SAVES LABOR** — Lamson Tubes release manpower formerly employed as messengers for productive jobs!

THIS BOOKLET, "WINGS OF BUSINESS," SHOWS MANY INSTALLATIONS. To learn how Lamson Tubes have cut cost and increased production on many jobs through a wide range of industry, write for a copy.

LAMSON CORPORATION
Makers of Conveyors and Pneumatic Tubes
250 Lamson St., Syracuse 1, N. Y.

MORE PUMP *in* LESS SPACE

Axial section of an IMO pump



Lubrication oil pump directly connected to shaft of steam turbine.

IMO

The IMO pump provides "more pump in less space" because it can be operated at high speeds and correspondingly high capacities, directly connected to and integrally mounted upon motors, turbines or other driving machinery—without the necessity of speed reduction gears.

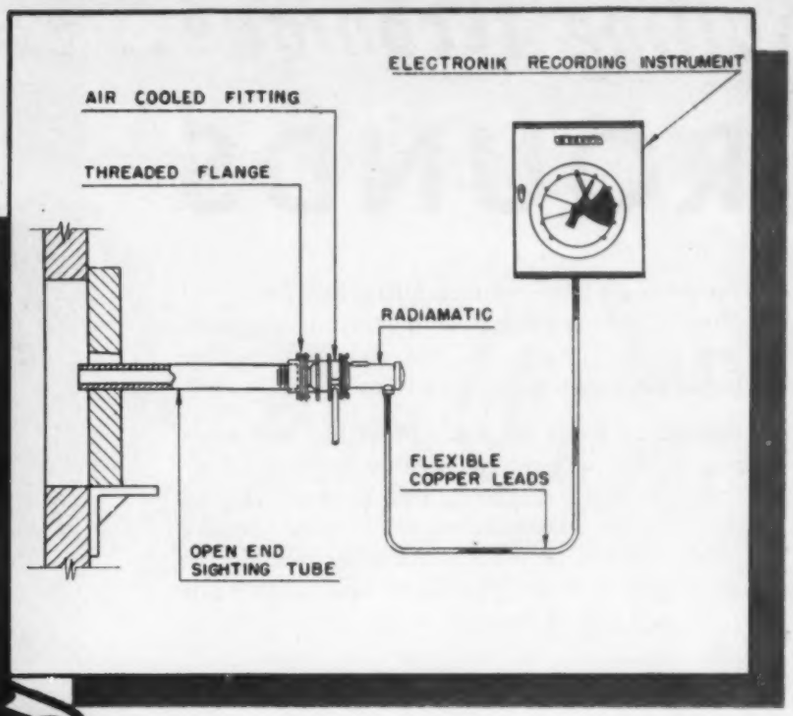
IMO — PUMP DIVISION OF THE DE LAVAL STEAM TURBINE CO. TRENTON 2, NEW JERSEY

Specialists for over a generation in

OIL IMMERSED MOTOR CONTROL

ROWAN CONTROL
THE ROWAN CONTROLLER CO., BALTIMORE, MD.

(Upper) Brown ElectroniK Potentiometer, with Radiamatic sighting unit, mounted as a portable instrument. (Center) Radiamatic sighted into furnace. (Lower) The Brown Circular Chart ElectoniK Recording Potentiometer.



How Hot is a Flame?

Human eyes can only guess—"Luminosity" is not the complete answer — recorded measurement of radiation characteristics is!

Chart records of flame radiating characteristics make possible greater heat input from fuel, higher tonnage, and lower fuel consumption per ton of steel produced.

Faulty conditions and inefficient furnace operation are often quickly revealed, and supposedly "ideal" flames can be greatly improved with the aid of Brown ElectroniK Potentiometers and Radiamatic sighting units.

Accuracy of the Radiamatic is unaffected by vibrations, dust, fumes and corrosive atmospheres. It is compensated for ambient temperatures and does not require water cooling.

Flame measurement is recorded by the Brown ElectroniK Potentiometer, which operates on the "Continuous Balance" principle, and provides instant response and unusual ruggedness.

As illustrated at left, the ElectroniK may be mounted easily on a cart, and moved readily for use at several furnaces.

Flame measurement is only one of many applications where the Brown ElectroniK and Radiamatic system is solving temperature problems in the operation of open hearths, soaking pits, blast furnaces, reheating furnaces and checker chambers of leading steel mills.

See what these instruments can do for you. Write for bulletin No. OH-1, "Measurement of Flame Radiating Characteristics"; ElectroniK Catalog No. 15-5; Radiamatic Catalog No. 5102. THE BROWN INSTRUMENT COMPANY, a division of the Minneapolis-Honeywell Regulator Co., 4464 Wayne Avenue, Philadelphia 44, Pa. Offices in all principal cities. 119 Peter Street, Toronto, Canada; Wadsworth Road, Perivale, Middlesex, England; Nybrokajen 7, Stockholm, Sweden.

BROWN *Electronik* POTENTIOMETERS

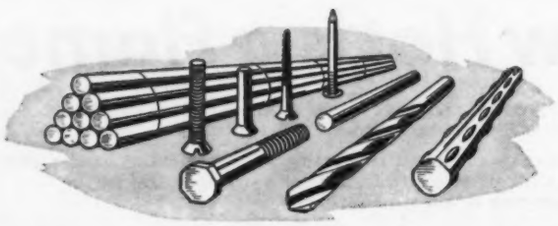
Rolling Technique..

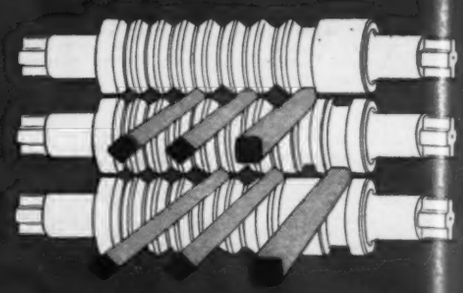
ROUNDS

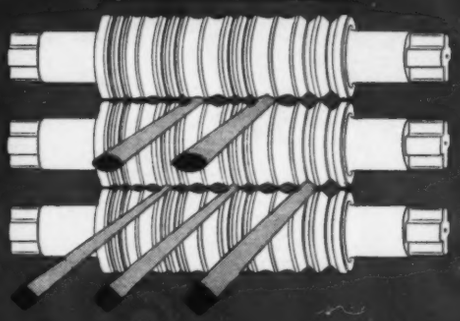
Increasingly better surface, finish, tolerances and physical properties are being demanded in products of bar, merchant, and rod mills. These improvements depend greatly on the rolls used.

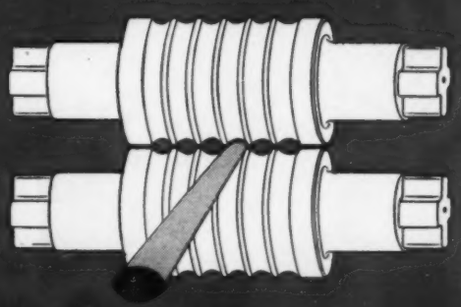
Pittsburgh Rolls are made by skilled craftsmen whose thorough practical knowledge of metallurgy, foundry methods, and accuracy in roll turning is the accumulated result of seventy-five years devoted to the exclusive manufacture of Rolling Mill Rolls. The use of Pittsburgh Rolls can result only in less cost per ton of steel rolled.

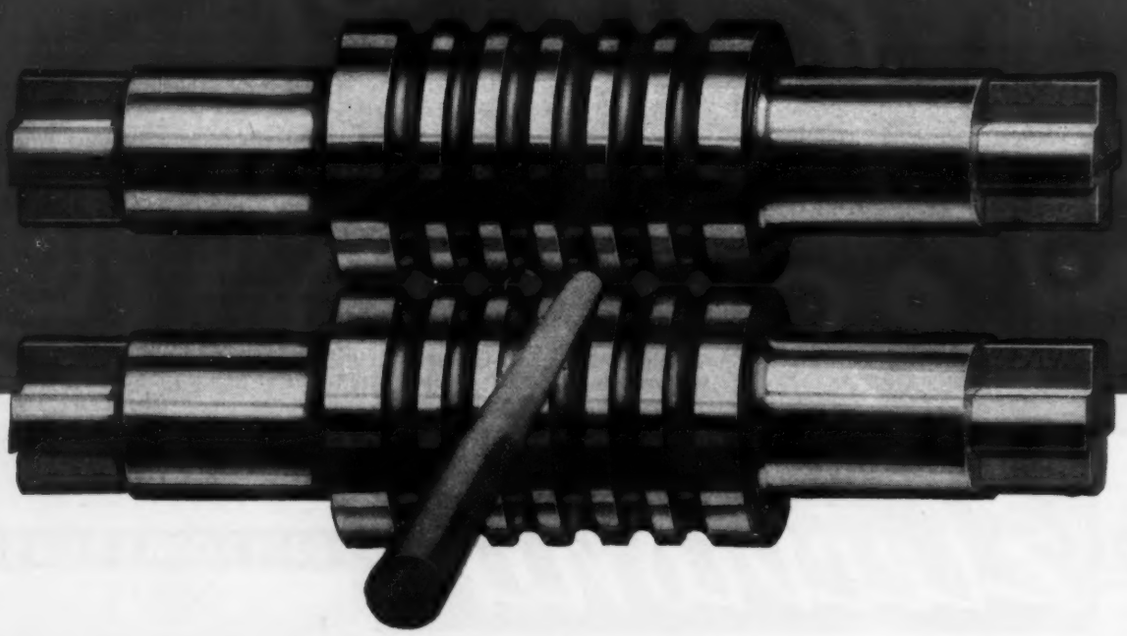
PITTSBURGH ROLLS
Division of Blaw-Knox Company
PITTSBURGH, PA.







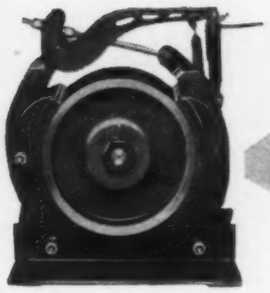




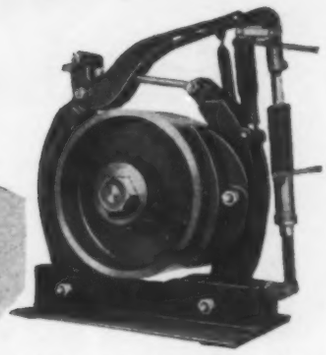
75 YEARS EXPERIENCE
1945

PITTSBURGH ROLLS

Wagner CAN SOLVE YOUR INDUSTRIAL BRAKE PROBLEMS



Type H brake for use where parking brake is not needed.



Type HM brake for use where parking brake is necessary.

for Your Present Requirements

If you have not yet installed Wagner Industrial Hydraulic Brakes, your problems of inadequate and inefficient braking can be solved by installing Type H (without parking brake) or Type HM (with parking brake). They are easy to order—and easy to install. When you order a Wagner industrial brake to replace one you now have, you receive a complete system which includes every part needed for its installation, and complete installation instructions.

Hydraulic brakes are now so universally applied to overhead cranes and other types of industrial machinery, that a repetition of their advantages over other types of brakes is hardly necessary today.

1. With Wagner industrial hydraulic brakes, the operator has *complete* control over the rate of deceleration—just as he has in his automobile.

2. If two brakes are involved, as in double-bridge braking, both brakes do an equal amount of work, and there isn't the strain on the machinery one encounters in unequalized mechanical brakes.

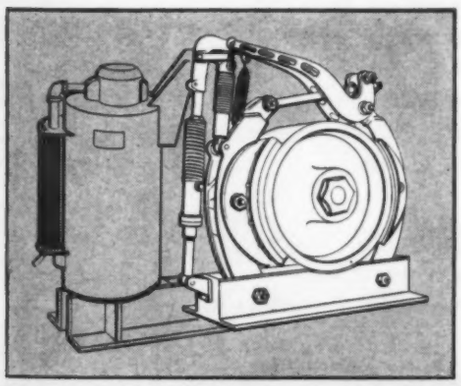
3. At all times, the brakes are actuated as soon as the operator steps on the brake pedal—no time loss, no energy loss.

4. The brakes are self-contained, involve no linkage, cables, rods, etc.; they are as simple in operation as the hydraulic brakes on your car.

5. In event of power failure, crane can be brought to stop as quickly as desired—hydraulic brakes are in no way affected.

for Modernizing the Wagner Brakes You now Have

If you have older Wagner Industrial Hydraulic Brakes, you will improve your braking system by modernizing your solenoid-type HM brakes, or you may have a Type H brake and find you now need the parking brake available on the improved Type HM brake. . . . Conversion kits are available for all HM brakes with solenoids (similar to diagram at the left), to replace the solenoids with the hydraulic-released spring-set cylinders. Also, kits are available to convert H-type brakes to HM brakes. Each kit is complete with all necessary parts and conversion instructions. Conversions are easily made.

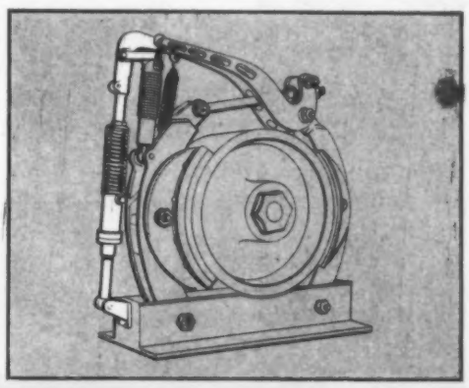


At left: Old-style solenoid brake can be readily converted to new-type HM brake.

At right: Type H brakes can be easily converted to type HM brakes.

Write for Complete Information

. . . write for descriptive data IU-34 for complete information on Wagner Industrial Brakes.



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Wagner Electric Corporation

ESTABLISHED 1891

6483 Plymouth Avenue, St. Louis 14, Mo., U. S. A.

ELECTRICAL AND AUTOMOTIVE PRODUCTS

Produced and Packaged under strict control for unvarying high quality

The unvarying high purity of Airco Oxygen (99.5% or better) is obtained through strict supervision of every manufacturing step by skilled and experienced Airco operating personnel, using the most modern scientific production methods, supplemented by regular testing and careful "packaging"

High purity oxygen has an important bearing upon speed, economy and efficiency in the use of every oxyacetylene flame process; particularly in cutting or related applications. A seemingly small difference of but ½ *of* 1% in purity can make as much as 10% difference in cutting speed and oxygen consumption.

Behind the guarantee of high-purity oxygen, the Airco trade mark also represents reliable deliveries to industrial areas — a responsible supply source for equipment and helpful engineering assistance on all applications of the oxyacetylene flame.

● An interesting booklet, "Oxygen — Indispensable Servant of Industry" is available free on request. Write to either the nearest Airco District Office or Department IS at the New York address.

AIR REDUCTION AIRCO

General Offices: 60 EAST 42nd STREET, NEW YORK 17, N. Y.

In Texas: MAGNOLIA AIRCO GAS PRODUCTS CO. • General Offices: HOUSTON 1, TEXAS

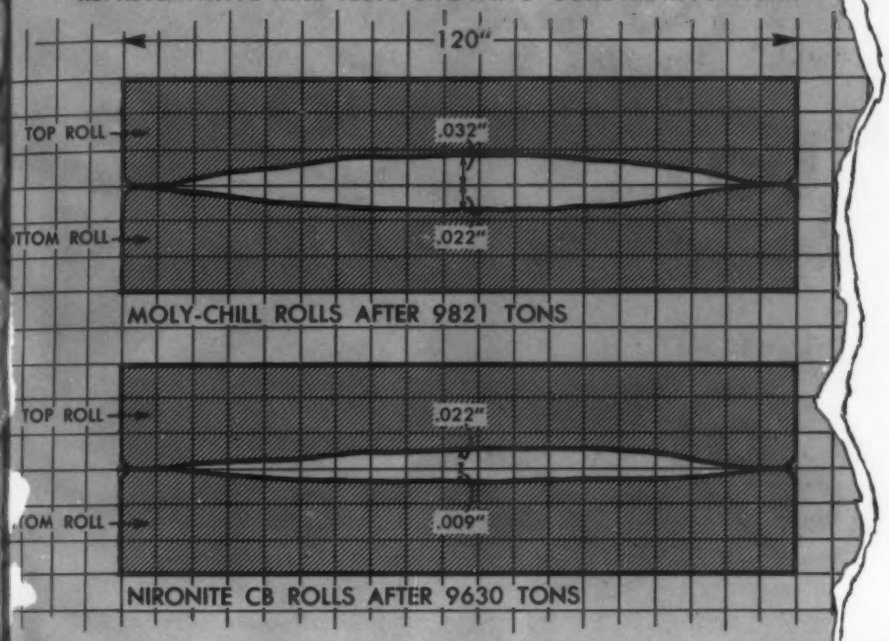
Offices in all Principal Cities

AIRCO OXYGEN GUARANTEED 99.5% PURE IN THE CYLINDER

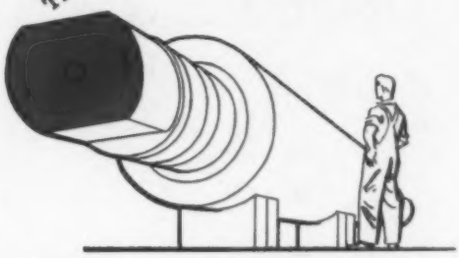
The fact of the matter:

NIRONITE CB WILL OUTWEAR ANY STANDARD PLATE ROLL

REPRESENTATIVE MILL TESTS SHOWING COMPARATIVE WEAR



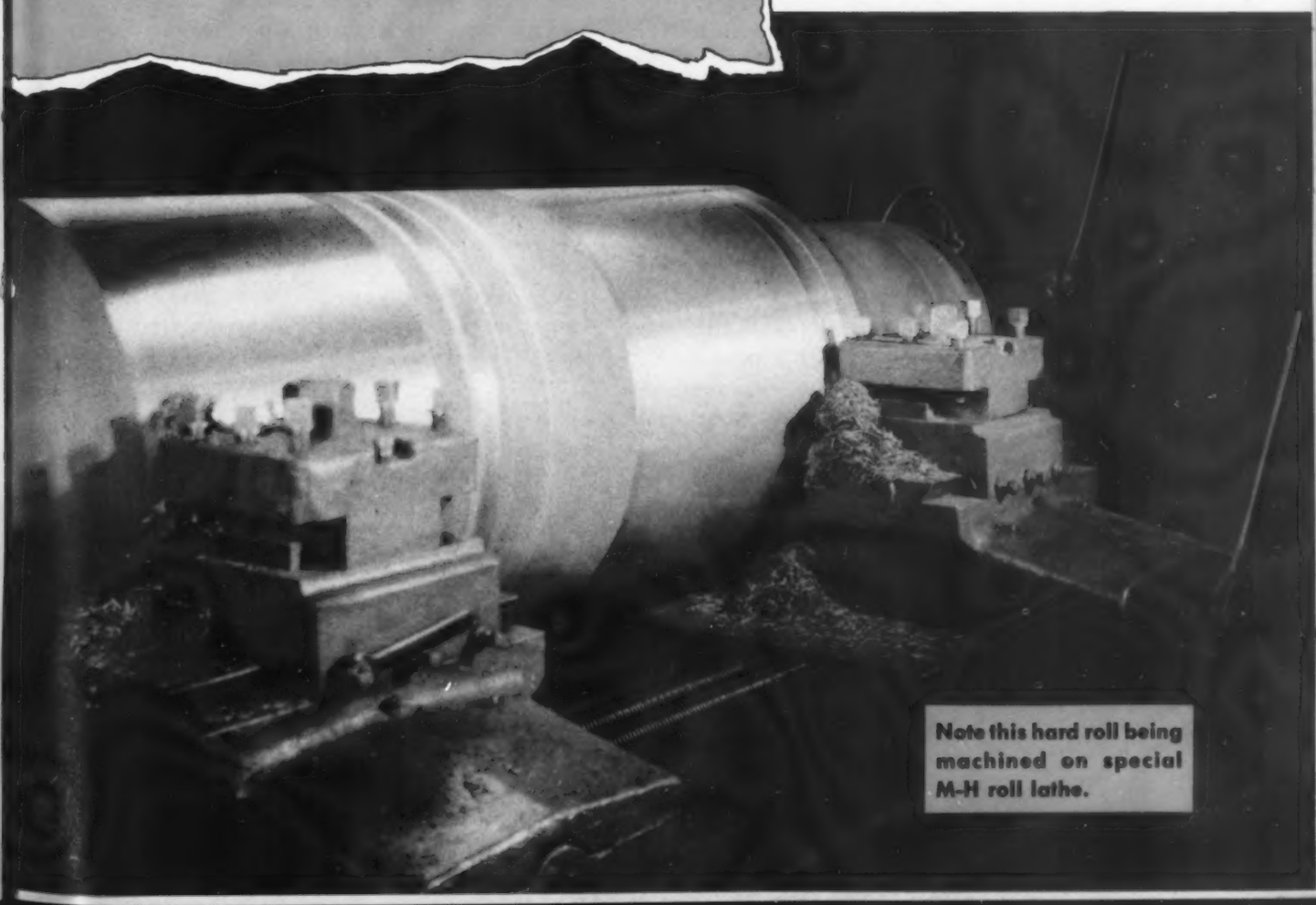
The rolls with the Red Wabblers



Remarkable wear resistance, freedom from fire cracking, tremendous strength —yes, anyone can use those *words* BUT —in *actual service* M-H Nironite Rolls *repeatedly* demonstrate wearing qualities that far exceed the record of any previously used standard rolls . . . M-H knows mills. They have been the originator of practically *every* major roll development. They advocate and practice machine roughing of rolls followed by light finish grinding, in contrast to wholly grinding from the rough. This eliminates the danger of weakening the surface structure by the generation of excessive heat in localized areas . . . Leading plate mills everywhere are saving time and production dollars and producing better finished products with Nironite CB Rolls. Write for quotation.

MACKINTOSH-HEMPHILL CO.

Pittsburgh and Midland, Penna.



Note this hard roll being machined on special M-H roll lathe.

SPEER CARBON BRUSHES ARE TROUBLE CHASERS...*in Motors and Generators*

Equip your d-c and slip ring motors, generators, and other commutating machines with Speer Carbon Brushes and watch them perk up. More and more users are finding that Speer brushes give utmost freedom from burning, overheating, sparking, excessive wear and energy losses, and other brush troubles that decrease operating efficiency, cause extra maintenance.

Good brush performance calls for brushes that are matched — electrically and mechanically — to the characteristics and service conditions of each machine.

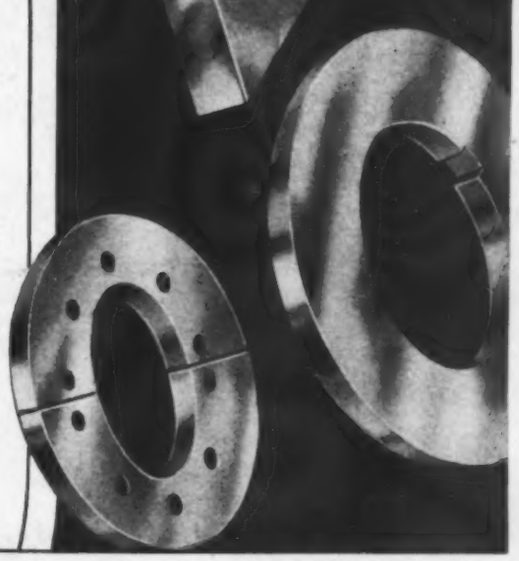
Matching brushes to machines has been one of Speer's specialties for nearly 50 years. From its all-inclusive selection of standard and special carbon, graphite, electro-graphite and metal-graphite brushes, Speer can supply the grade that will mean peak performance, fewer brush renewals and less maintenance on any application.

So, if you want to be sure of trouble-free brush operation, switch to Speer. You'll get sound practical service, plus quality brushes matched to your machines. See your favorite supply house or electrical contractor, or write direct for Brush Data Forms.

CHICAGO • CLEVELAND • DETROIT
MILWAUKEE • NEW YORK • PITTSBURGH

SPEER
CARBON COMPANY
ST. MARY'S, PA.

Wapakoneta Knives



Solid Steel or Laid

properly tempered and ground to suit your most exacting needs.

Shear Blades and Circular Slitters

in

Shock Resisting	*Multicut*	*Standard Alloy*
Super Alloy	*Hot Work*	*Laid High Speed*

Write and tell us your problem

The Wapakoneta Machine Company

Incorporated 1891

Wapakoneta, Ohio

LINCOLN

Single Line

CENTRO-MATIC LUBRICATING SYSTEMS

The trolley unit of a heavy-duty overhead crane, illustrated at left, is equipped with a Lincoln Centro-Matic System. All bearings on this trolley unit are safely and easily lubricated from the catwalk by means of a hand-operated Lincoln Lubricant Pump.

Reduce Industrial Hazards

Industrial accidents frequently occur to workmen lubricating grease fittings placed in hazardous locations. This is especially true on the trolleys of heavy cranes operating over high runways. When cranes are equipped with Lincoln Centro-Matic Lubricating Systems this danger is reduced to a minimum.

These systems also eliminate "skipped bearings" because a Centro-Matic Injector is provided for each individual bearing, assuring the delivery of a measured amount of lubricant to all bearings every time the Centro-Matic Lubricant Pump is operated.

Lincoln Centro-Matic Lubricating Systems are single-line systems, and can be applied to all types of machinery and equipment that require lubrication. They are simple to install and are furnished with either manually-operated or power-operated lubricant pumps. Power-operated systems can be time-clock or push-button controlled.

Save BEARINGS, MACHINE HOURS, MAN HOURS, POWER and Prevent Accidents

Send for this Bulletin Today

Complete bulletin describing the Lincoln Centro-Matic Systems will be sent to you upon request. The coupon at right will bring your copy. If you have a special lubrication problem, write us, enclosing a blue print or specifications of the machine you wish to lubricate and our engineers will gladly make a recommendation. No obligation.

I WOULD LIKE TO HAVE FREE BULLETIN
On Lincoln Single Line Centro-Matic Lubricating Systems

*Name*_____

*Title*_____

*Company*_____

*Address*_____

*City*_____ *State*_____

ISE 8256

ARMY E NAVY

LINCOLN ENGINEERING COMPANY

Pioneer Builders of Engineered Lubricating Equipment

5701 NATURAL BRIDGE AVE., ST. LOUIS 20, MO., U. S. A.

LINCOLN

NEWS SUPPLEMENT April, 1945

Equipment
Personnel
Literature

Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

BUREAU OF MINES INVESTIGATION PROVES COKING COAL RESERVES IN WYOMING

▲ Seeking additional sources of fuel for the blast furnaces of the West's warborn steel industry, a Bureau of Mines diamond-drilling program has proved a reserve of 15,345,000 tons of coking coal in the Kemmerer district of Lincoln County, Wyoming, Dr. R. R. Sayers, director of the bureau, announced recently.

An estimated 11,215,000 tons of this coal in the Willow Creek bed are considered recoverable, the director said, releasing a published project report prepared by Albert L. Toenges, J. D. Davis, Louis A. Turnbull, and J. M. Schopf, of the bureau.

Prior to the war, the only known sources of metallurgical coking coal available west of the Continental Divide were the Lower Sunnyside bed in Carbon County, Utah and certain high-ash coking coals in the State of Washington.

Carbonization tests on the Willow Creek coal at the bureau's laboratories in Pittsburgh disclosed that coke made from this fuel — a high-volatile A bituminous — was somewhat weaker than that produced from Utah's Sunnyside coal. However, a blend of equal parts of the two coals yielded a coke that met the standards of the Columbia Steel Company. Coking properties can be improved by cleaning, indicating that the mine-run coal should be prepared in a mechanical cleaning plant because partings in the bed cannot be removed effectively by hand, the publication said.

On government-owned land, the bed considered minable — known as the Middle Main bed of the Willow Creek group — averages 54 inches in thickness and underlies 1,710 acres of surface in three areas near Kemmerer. The field can be opened by two mines at a cost of approximately $1,400,000, and highway, railroad, and water facilities would require an estimated additional outlay of $330,000, the report stated, fixing mining costs under present conditions at about $3.10 a ton.

Thickness, physical characteristics, and extent of the Willow Creek bed and underlying and overlying strata were determined from core samples. Interpretations of the drilling data, chemical and petrographic analyses, coal constitution, and the results of carbonization tests are presented in the publication, together with a plan of development.

Modern equipment in this new test floor effects many economies in testing d-c motors. Efficiency tests may be performed on 40 machines a day.

NEW MOTOR TEST FLOOR PUT INTO OPERATION

▲ A modern motor test floor for running efficiency tests on as many as 40 direct-current machines a day has been built and recently put into operation at Allis-Chalmers' Norwood Works, Norwood, Ohio.

Eleven test bases and rig machines, ranging from 10 hp to 250 hp, are available for d-c testing. The rig motors are equipped with Magic-Grip sheaves, couplings and combination sheave couplings, which provide for the tandem operational test frequently desired on the load-back method of testing two machines under full load. The tandem testing rig operates with a 250 hp motor and combination sheave coupling, which

provides mechanically for testing four 250 hp motors fully loaded in tandem.

A time saving — amounting to a ratio of 4 to 1 on heat runs and other expensive tests — is effected in the arrangement which requires the rig motor to supply only the losses of a four test machine. For each rig machine an individual test table equipped with a separate set of instruments provides further time saving, as well as protection for the instruments.

For safety and convenience, dead front switchboards are used and equipped with voltage regulators. Dead load resistance records for loading generators are located between test tables and are so arranged that any desired load can be placed on the test machine.

Zero to 300 volts are available for field excitation of test machines and zero to 500 volts are available in the power circuits to rig and test machines.

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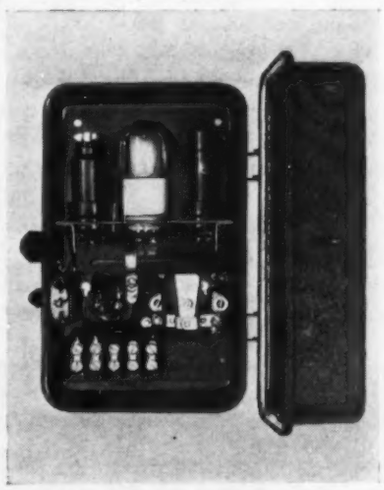
PHOTOELECTRIC CONTROL FOR AUTOMATIC POURING

▲ Photoswitch photoelectric control type A20C provides an answer to the need for automatic control of pouring operations in foundries where it is fast replacing hazardous and less efficient hand-pouring methods. Before introduction of this modern system, molds were poured by means of a manually operated buggy ladle handled by an operator who was subjected to intense heat from the iron and occasional burns resulting from iron splash. With the help of Photoswitch "electric eyes," one operator, working from a remote station, now controls the pouring of several ladles simultaneously. The hazards encountered in hand pouring are completely eliminated and several molds are now poured in less time than was needed to pour one by the former method.



As each of the group of empty molds moves into position before a ladle, a Photoswitch photoelectric control mounted directly above watches through a viewing tube. When the molds are in place, the operator, through push button control of the hydraulic actuating mechanism, tips the ladles of molten iron and the whitehot metal flows into the molds. As it reaches the riser of each mold, a brilliant light is thrown off a signal to the watching "eye" that the mold is full. Photoswitch instantly drops the ladle back and the pouring automatically stops.

Type A20C provides precise control of this and many other widely differing processes because of its

ability to detect minute changes in light intensity. An adjustment on the control housing may be set so that the control will remain inoperative at one level of illumination, but will be actuated when the amount of light reaching the phototube varies slightly. It is therefore used to indicate and control the density of gases as well as turbidity in liquids. Type A20C, in addition, can distinguish between a clear liquid such as water and air above it, or can detect an interface between two liquids differing slightly in translucency.

Control type A20C operates from a supply of 115 volts a-c 60 cycles and incorporates a single-pole double-throw relay for normally open or normally closed operation. Relay contacts are designed to handle 10 amperes a-c or 5 amperes d-c.

FORK TRUCKS PERFORM WIDE RANGE OF WORK

▲ Fork-type power industrial trucks are used regularly in three different ways by a manufacturer of welding rods to expedite the flow of material from box cars to processing equipment, and from thence back to cars for shipment to plants here and abroad.

An expediency born of the war is proving practical and suggests similar applications in other industries. Fork trucks, as is well known, were developed especially for conveying and tiering loads on pallets and skids. But they can be used effectively in other ways, as this experience proves.

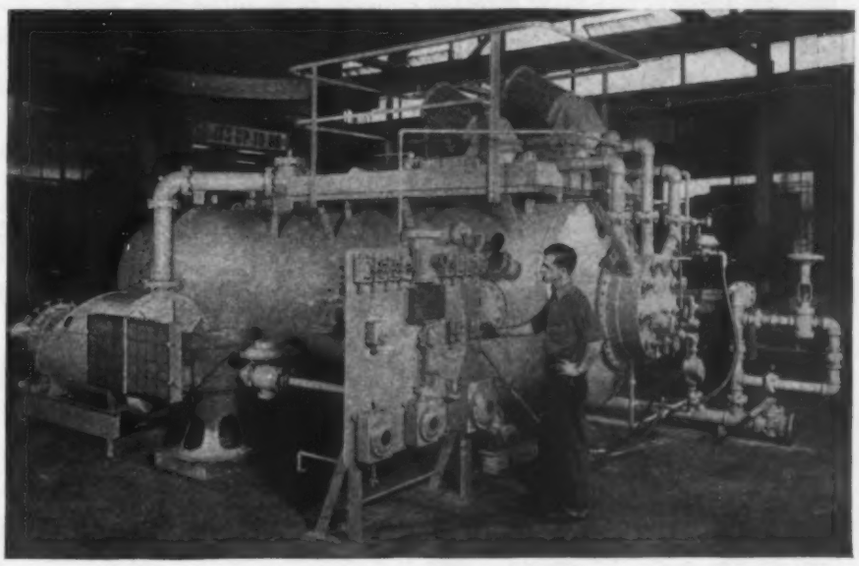
The manufacturer of welding rod each day receives an average of 250,000 pounds of unfinished wire in coils, processes it, boxes and ships it in the form of welding rods. Two Elwell-Parker fork-type trucks handle most of the raw materials and finished products in this continuous manufacturing cycle.

Coils of wire are first stacked manually side by side, almost vertically, in the freight cars. Each prong of a fork then engages five coils of wire, and the ten coils collectively weighing 2 tons are lifted at one time and conveyed 100 feet to receiving bins. The bins adjoin machines which straighten the wire, cut it to length and eject the rods into steel boxes. These boxes have holes pierced near their upper edges. The fork lifts four of them at one time by means of hooks and short lengths of chain. Finally, the same trucks are used in the conventional method of lifting the packaged rods on pallets or skids and transporting them 100 feet to cars, or to storage.

METAL SAW LUBRICANT INCREASES BLADE LIFE

▲ A lubricant for band saw teeth, prepared in the form of a stick 6 inches long and 1 inch in diameter, has been developed by the Kindt-Collins Company, Cleveland, Ohio.

This lubricant is applied by pushing the stick against the teeth of the saw blade while it is in motion. When used on a metal-cutting saw, it makes the cutting easier and faster, and substantially increases the life of the saw blade. It prevents chips from clogging the teeth, thereby preventing much breakage of teeth. When used on a wood-cutting saw, the lubricant prevents pitch from forming on the saw blade.



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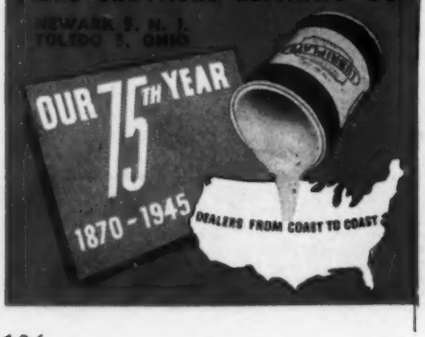


ARC WELDING EXPERIENCES BROAD DEVELOPMENT IN PRACTICE AND EQUIPMENT

▲ The progress of arc welding has seen rapid developments not only in increased volume of weld fabrication in all metal making and metal using fields, but also in improvements in welding equipment, supplies and techniques for its use.

Due to the inherent characteristics of arc welding as the fastest and most economical process for joining metals, it has been recognized by production authorities as the chief reason why the Allied nations have been able to outproduce the Axis and gain the initiative in all theaters of war.

Some of the advancements include the production of the new Lincoln 200-ampere "Shield-Arc" engine-driven arc welder which is more useful and efficient as compared with former units of this type. It is powered by a four-cylinder, 29 horsepower engine rated at 1400 revolutions per minute.

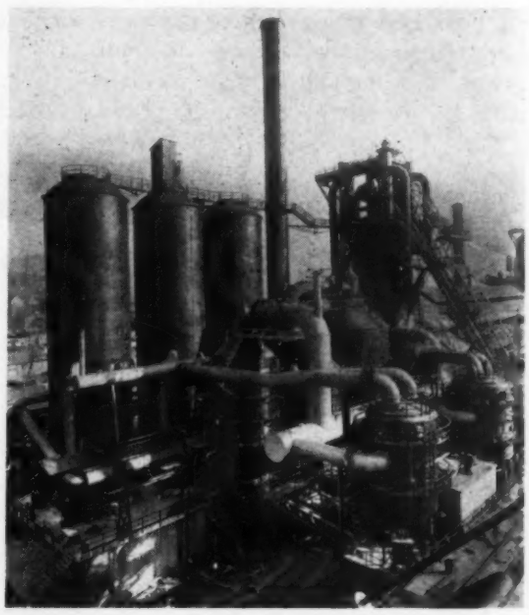
Another useful item recently developed in the field of welding is a unique type of arc welding control, which enables the welder to speed up his work and do a more accurate job.

The control, called the "Lincontrol," which is almost as light as a shoe, is strapped onto the welder's foot and enables him to move about with it freely. It is applicable for welding light-gauge sheet metal in manufacture, construction and maintenance.

With the control strapped to his foot, the welding operator merely presses down on the pedal which moves the pin to operate a current control. As he exerts pressure he increases the current.

This permits very accurate control over the welding arc, and achieves in one unit the same results as both the so-called "hot-start" and "crater eliminator." Because he has complete control, he can adjust the arc at any time without changing his position. Yet while welding in and around a fuselage assembly on "pick-up" work, he can move around at will without hindrance of constantly keeping his foot in one place as is necessary with conventional foot controls.

Thus, the control eliminates the necessity of making adjustments on the welding machine, due to such things as minor changes in thickness, and changes in fit-up and enables the operator to weld in any position which he finds convenient or comfortable. The complete control of the arc gives an improvement in the quality of the weld, reducing the danger of a weld burning through or getting poor fusion or penetration.



Typifying the wide usage of arc welding in steel plant construction, this modern blast furnace uses welded construction for stack, stoves, skip, dust catcher, whirlers, humidifier system and much of the piping.

A general-purpose electrode just perfected has found wide acceptance for the welding of mild steel. It has an extremely stable arc that does not tend to burn through even when welding light sheet or where joint fit-up is poor. Designated as "Fleetweld 37"

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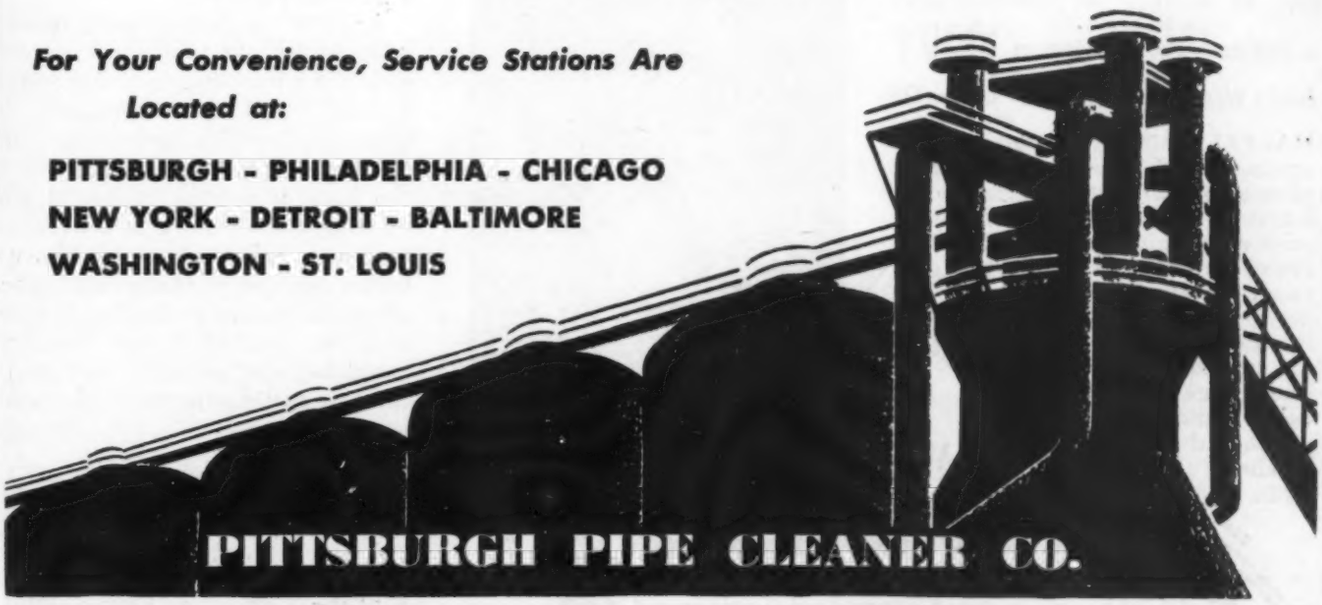

413 Melwood Street **Pittsburgh 13, Penna.**

this new shielded arc electrode is used in all welding positions and is extremely easy to handle, builds up a smoother weld bead and deposits the weld at a rapid rate.

The practicability of the arc welding process for the construction of blast furnaces as well as for many other types of mill and plant structures is confirmed in Figure 1, which shows one of the largest blast furnaces in existence typical of many such structures.

The photo shows the furnace with its all welded skip hoist together with three all welded stoves and welded stacks, an all welded dust catcher in front of the first stove, several thousand feet of arc welded piping, two all welded whirlers and a welded humidifier system for air conditioning the blast.

This has been 100 per cent satisfactory. At the present time it is not the only all welded furnace, since several of them have been all or partially welded or rebuilt by welding. However, it is of particular interest because it is another one of those "couldn't-be-done" jobs which was finally licked. Not only is this furnace nearly structurally perfect, but it also has smaller tolerances than the standards previously allowed. According to recent operating reports, its efficiency has proven higher although it cost considerably less to erect, and it will be much easier to maintain in the future.

In the field of welding technique, the use of larger sized electrodes has become a firmly established practice in all sorts of fabricating jobs. Among others, the shipbuilding industry has benefitted greatly. In order to convince anyone who might doubt the advantage to be gained in using larger electrodes, one Pacific Coast shipyard held a comparison test in which two bulkheads were welded, one with a $\frac{5}{32}$-inch electrode and the other with $\frac{1}{4}$-inch size.

Results of the comparison showed that the job completed with the larger size electrode turned out to be entirely satisfactory. According to the report, the management of the yards was relieved of all doubts as far as usage of the larger electrode is concerned. They report that speeds have been materially increased over those formerly obtained by using electrode of American Welding Society E-6010 specification.

The "Fleet-Fillet" technique of arc welding, which permits up to 100 per cent faster fillet welding and which thus greatly speeds up production of welded ships, tanks, guns and other war-vital products, is another important advancement that has come into wide usage.

Many fabricators have instituted a program of rigid engineering control during the past year in order to effect greater savings through welding. This control has been facilitated by the widespread use of jigs and fixtures used as an aid in assembly and manipulation during welding. The efficient use of such devices has brought about careful analyzation of the parts to be welded into an assembly or sub-assembly. In practically every instance, jigs and fixtures have been found to be ideal accessories for reducing the amount of mental and physical effort necessary to complete the work.

By means of these devices it is possible to so position the welding that it can all be made downhand, effecting a saving as much as three-quarters of the arc time compared to overhead welds. Then, too, less time will be wasted by the welders in going from one weld to another — making higher operating factors possible. Many shops are now in existence where the operating factor is as low as 20 per cent. Increase in this item to 60 per cent will cut the cost of the weld by 65 per cent.

Another interesting development designed to add to the overall efficiency of arc welding is in the form of a small, pocket-size calculator to determine welding preheating temperatures. This useful device is in the form of several cardboard disc sections and serves as a convenient guide in instances where steels have a higher content of carbon and other alloys and require preheating to minimize the tendency toward excessive hardening and possible cracking of the base metal adjacent to the weld.

HEATER AIDS UNLOADING OF VISCOUS LIQUID FROM CARS

▲ Newly introduced by The Brown Fintube Company, Elyria, Ohio, manufacturers of resistance welded, integrally bonded fintubes and fintube heat transfer products, a new

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immersion type steam tank heater is ideally used with any material, the viscosity of which can be lowered by heating. The heaters speed up the emptying of tank cars and permit many viscous materials to be handled in cars not fitted with steam coils.

As illustrated, the heater consists of a number of lengths of Brown Fintubes connected in series, and inlet and outlet steam lines. The heaters have low center of gravity. They can be handled safely by one man, or very easily by two men. Cross handles aid in positioning the heater over the discharge outlet in the car, in blocking the heater at various depths, and removing the unit after the car is empty. Furnished in two sizes — the No. 642 for use with tank cars, the No. 442 for use with tank trucks.

NEW OWNERSHIP FOR MANUFACTURING COMPANY

▲ Walter Kidde and Company, Incorporated of Belleville, New Jersey announce that they have purchased the capital stock of the Youngstown Miller Company, Incorporated, formerly of Sandusky, Ohio, manufacturers of plastic coaters and oil reclaimers. Orders on hand will continue to be filled under the direction of F. L. Gerin, who becomes vice president and general manager. Other officers of the new subsidiary of Walter Kidde and Company, Incorporated will be John F. Kidde, president, Harold A. Cartier, vice president, G. Crosby Hiss, secretary and William Deyerberg, treasurer and comptroller. R. E. Strobel will continue as sales manager for the Youngstown Miller products.

The Youngstown Miller Company for the past 10 years manufactured a line of batch reclaimers for all types of lubricating, hydraulic, and cutting oils. They recently developed the Robot refiner for continuous cleansing operations of large quantities of oil in constant process use. Other products which this company will continue to manufacture and sell include a complete line of plastic coaters for melting ethylcellulose and other plastics used in coating parts with a waterproof, corrosion-resistant protection for overseas shipment or storage.

Sale of these products will continue through selected distributors and representatives of the parent company. The main office of The Youngstown Miller Company will be located at 675 Main Street, Belleville, New Jersey.

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3 Depths. 1½, 2¼, or 3 inches inside.

Listed in Condulet Catalog No. 2500, Section 15, Page 31.

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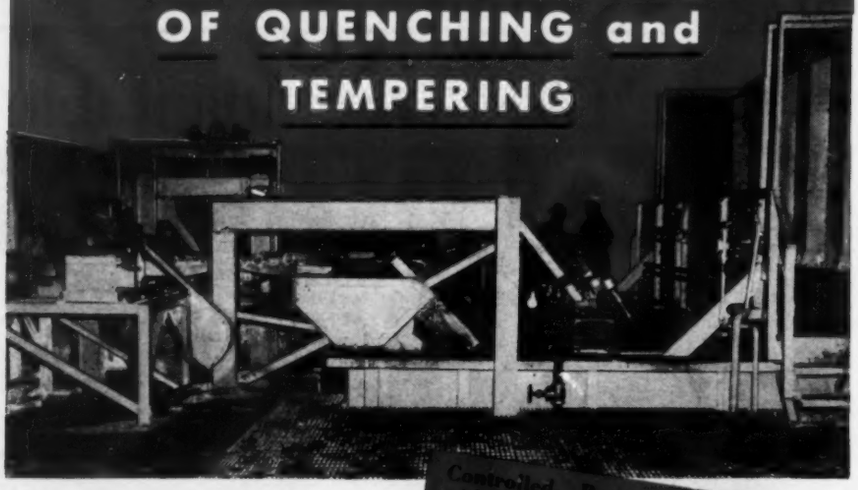
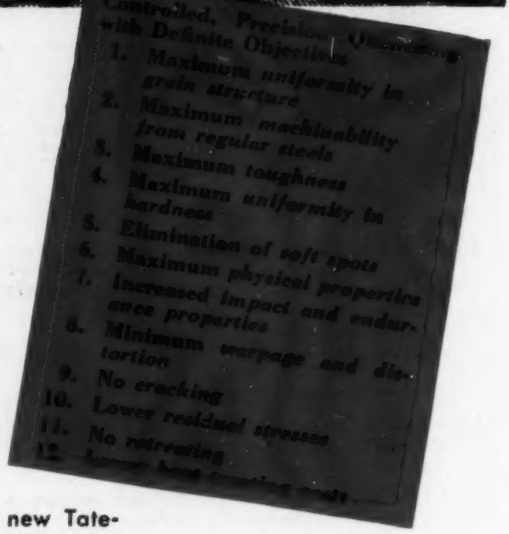


The results at the right apply to either carbon or alloy commercial steels.

Orthodox and other quenching methods whether slow agitation or spray quench, do not develop these results consistently and uniformly as the Purnell process does.

We will be glad to explain how these results are accomplished if you are sufficiently interested to correspond with our Vice President, in charge of sales, Mr. Chas. G. Purnell, Tate-Jones & Co., Inc., P. O. Box 1016, Pittsburgh 30, Pa.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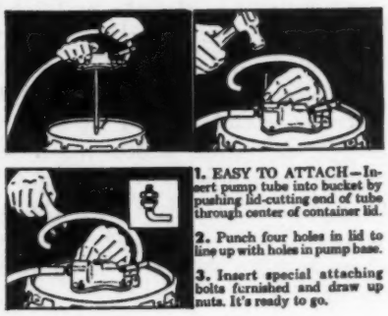
LUBRICATING DEVICE FEEDS FROM ORIGINAL CONTAINER

▲ The new Lincoln Handi-Luber makes it possible to convert an ordinary original grease container into a 25-lb high-pressure grease gun. Low in cost and great in utility, this unit is ideally suited for use on farms, in shops, mills, mines or factories, and for lubricating contractors' equipment. It is the latest addition to the line of lubricating equipment manufactured by the Lincoln Engineering Company, St. Louis 20, Missouri.

MODEL 1266



1. EASY TO ATTACH—Insert pump tube into bucket by pushing lid-cutting end of tube through center of container lid.

2. Punch four holes in lid to line up with holes in pump base.

3. Insert special attaching bolts furnished and draw up nuts. It's ready to go.

Model 1266 Handi-Luber is a compact, sturdily built high pressure grease pump equipped with a 5-ft hose assembly with hydraulic coupler for contacting all Kleenseal and hydraulic fittings. Manually operated, dispenses either light cup grease or viscous types; easily develops 5000 psi pressure. One man can operate and carry the Handi-Luber with ease. No transfer of grease is necessary.

NEW SHEAR ADAPTABLE FOR BARS, PLATE, ANGLES

▲ A new line of open-end vertical bar shears, designed in 10 sizes and with ram pressures of from 25 to 300

tons, has been announced by Thomas Machine Manufacturing Company, Pittsburgh, Pennsylvania. Shearing capacities for rounds range from 1 in. to 3 in.

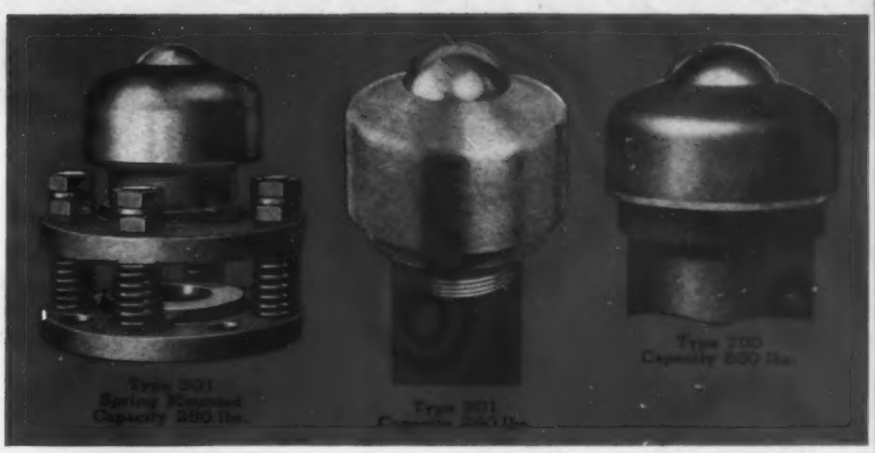
One of the new open-end vertical bar shears being introduced by Thomas Machine Manufacturing Company. These shears can also be adapted for punching and for plate and angle shearing.

The open-end feature represents a major improvement over conventional closed-end shears, enabling quicker, more accurate handling and making the shear blades easy to see and change. The new shears also have the advantage of being adaptable for punching, and plate and angle shearing. The ram is machined for attaching various types of punching tool arrangements, including single, double or triple gagged units, cluster punches or floating punch.

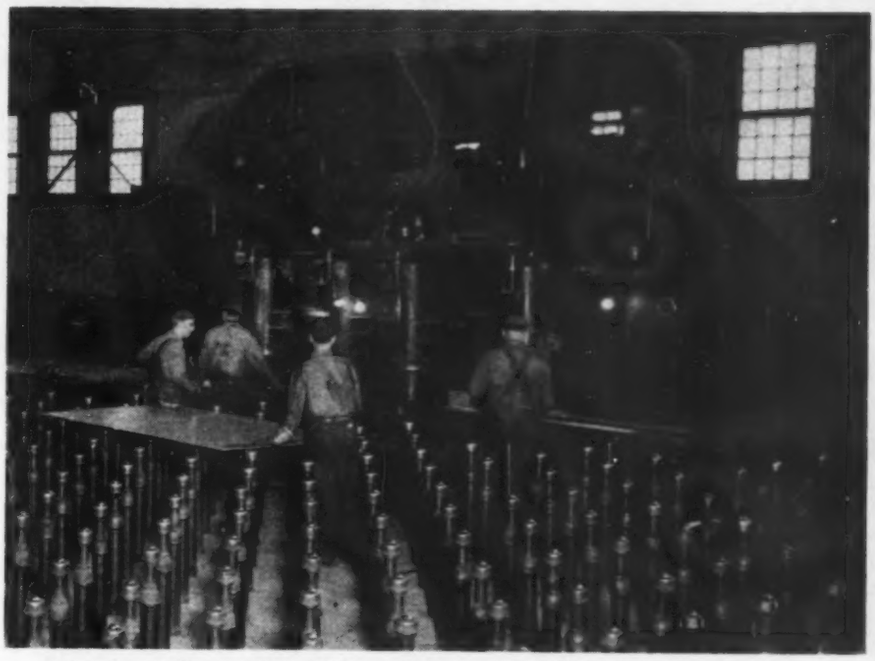
Frames of the new machines are constructed of rolled steel plate with heavy steel throat section welded into place. The multiple jaw type clutch has a positive automatic kick-out for stopping ram at top of stroke. Flywheel is mounted in roller bearings located within frame for safety and to eliminate overhung load on bearings. A V-bell motor drive provides quiet operation and reduces shock load on the motor.

REPUBLIC PURCHASES IRON ORE FROM TEXAS

▲ Republic Steel Corporation has signed a contract with the Lone Star Steel Company, Daingerfield, Texas,



Ball Transfers
SPEED PLATE HANDLING



For handling plates into shears, punches or presses, for transferring slabs, sheet packs and similar loads, ball transfers are extremely efficient. The plates move into position with a minimum of effort, and can be moved sharply in any direction without any preparatory circular motion, such as is necessary when inverted casters are used. The cap on the transfer keeps dirt out and tends to keep the main ball clean. Tapered holes in the bases provide exit for dirt which might get into the unit. The contour of the cap affords no projecting bolts or edges to be knocked off or battered by drooping plates. The caps are removable so that the units can be cleaned thoroughly from time to time. The range of heavy duty sizes shown above is adequate to meet most requirements.

DELTABESTON CABLES

Are Safe

IN CONSTANT, HIGH HEAT

One of the most practical ways of avoiding frequent power failures in circuits that operate in steel mills is to rewire with Deltabeston Power Cables, Type AVA. Deltabeston is designed to provide trouble-free service in boiler rooms, furnaces, soaking pits, kilns, steam tunnels, etc. These heat-resistant cables have proved in numerous installations that they are unaffected by steady, high heat. They stand up in severe operating conditions because Deltabeston is insulated with an impregnated felted asbestos insulation that just won't bake out.

And don't overlook Deltabeston Motor Lead Cables, Type AVA for rewiring low-voltage apparatus in steel mills. These cables successfully resist excessive heat, high humidity, most corrosive vapors and still maintain their fine flexibility. Next time rewire with Deltabeston Asbestos-insulated Cables and be safe.

This catalog will help you select the right cable for installations where heat is a problem. Write to Section Y453-31, Appliance and Merchandise Dept., General Electric Co., Bridgeport, Conn. All Deltabeston Wires and Cables are distributed nationally by Graybar Electric Company, General Electric Supply Corp., and other General Electric Distributors.

BUY WAR BONDS AND KEEP THEM

GENERAL ELECTRIC

which calls for 100,000 tons of concentrated East Texas iron ore.

Shipments, which will be by rail, approximating 25,000 tons of beneficiated ore monthly, will be made from Lone Star's Daingerfield plant to Republic's plants in Birmingham and Gadsden, Alabama.

Tests of the East Texas ore show that the beneficiated product contains well over 60 per cent of iron units.

NEW LINES OF BLOWERS AND FANS ANNOUNCED

▲ New efficiency and new economy are outstanding characteristics of two new lines of pressure blowers developed by Buffalo Forge Company, Buffalo, New York. The unit designated as type "CB" (centrifugal blower) has a capacity range from 200 to 5,000 cfm and a pressure range from ¾ to 2 psi. The type "CC" (centrifugal compressor) Unit ranges in capacity from 4,000 to 75,000 cfm, at pressures up to 4 psi.

Developed from results of vacuum pit testing, the rotors used in both these units are largely responsible for the fine performance obtained.

While both these designs are just now offered to industry, they are actually the product of long and careful research work, climaxed by the insistence of war demands for fans of this type. Hundreds of these fans are already in use, with excellent results. Complete data and ratings are contained in bulletin No. 3553.

The company is also offering a new, moderately-priced line of highly developed axial flow fans for general ventilating and air conditioning service. This is the Buffalo type "B" line, using a welded steel wheel, with large hub and varying blade pitch to give uniform air flow over the entire blade. Large hub prevents re-entry losses common to the ordinary propeller fan. Housings are heavy gauge welded steel, rigid motor supports permit use of standard motors.

Type "B" axial flow fans are offered in belted or direct connected models, in capacities up to 45,750 cfm, and pressures ranging up to 1½ in. static. Belted models are Vaneaxial only (with stationary directional vanes); direct connected models are Vaneaxial or Tubeaxial (without vanes). Complete ratings and details of construction are contained in bulletin No. 3533.

SHIFTS IN MANUFACTURER'S DISTRICT REPRESENTATIVES

▲ The Thomas Flexible Coupling Company, Warren, Pennsylvania, has announced the appointment of the Brooks Equipment Company as their exclusive sales representative in Oregon, Washington, and Northern California with district sales offices located in Portland, Seattle, and San Francisco. W. A. Hoppe of Los Angeles continues as exclusive representative for Southern California.

The W. G. Kerr Company, sales representative for the Thomas Flexible Coupling Company in the Pittsburgh district, have moved their offices to the Oliver Building, Pittsburgh, Pennsylvania.

WILPUTTE COKE OVENS IN WAR EXPANSION PROGRAM

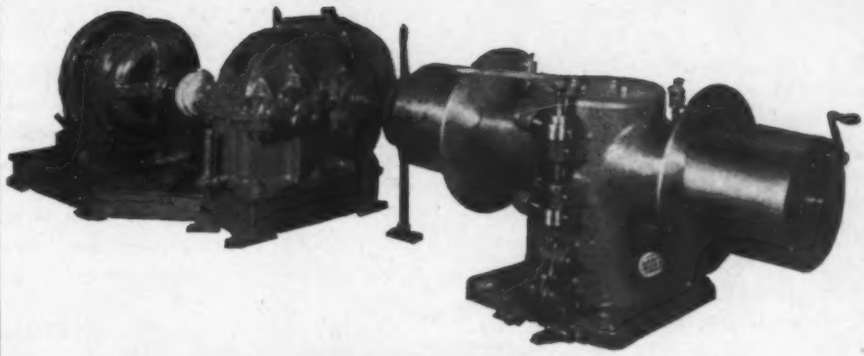
▲ Twelve batteries of underjet high and low burner by-product coke ovens, totalling 682 ovens, with an annual coal capacity of 5,951,900 tons is the Wilputte Coke Oven Corporation's contribution up to date to the war's demands on our metallurgical industry.

In the United States, Wilputte plants have been built during the war for the following firms: E. I. duPont de Nemours and Company, Morgantown, West Virginia, two batteries, 74 ovens; Semet-Solvay Company, Ironton, Ohio, one battery, 76 ovens; Tennessee Products Corporation, Chattanooga, Tennessee, one battery, 20 ovens; Bethlehem Steel Company, Lackawanna, New York, two batteries, 152 ovens; Carnegie-Illinois Steel Corporation, Gary, Indiana, one battery, 77 ovens; Republic Steel Corporation at Warren, Ohio, one battery, 61 ovens; at Gadsden, Alabama, one battery, 65 ovens; at South Chicago, Illinois, one battery, 75 ovens; Interlake Iron Corporation, Perry Works, Erie, Pennsylvania, one battery, 35 ovens.

Under construction for Citizens Gas and Coke Utility, Indianapolis, Indiana, one battery, 47 ovens.

In four of the above plants, Wilputte has installed the latest development in by-product equipment for the production of ammonium sulphate, the Wilputte crystal sulphate equipment, producing uniformly controlled size of ammonium sulphate crystals.

COIL HANDLING



EQUIPMENT By *Yoder*

DEVELOPMENT of coiled strip in a constantly increasing variety of widths, gauge and material has been an important factor in the advancement of high speed production in stamped, punched, drawn and roll-formed metal products. Yoder has specialized in the engineering and building of special handling equipment from the early days of strip making.

Today Yoder builds coil handling equipment as varied as industry's needs, from simple ball-bearing coil boxes to cone type uncoilers with drag generators and from simple stock reels to huge tension reels for steel mill use. The patented double-swivel type recoiler, shown above, which handles single or multiple coils up to 6,000 pounds, is made so that coils can be unloaded from one side while the other is recoiling . . . The coil box at right is the simplest form made, ball bearing, easy to load, compact, suitable for serving a wide variety of strip-fed production machines. There are many other types.

These machines may be had with Yoder pinch-roll feed stands, levellers, edge trimmers or as integral parts of complete Yoder-built slitting or roll-forming lines. If your coil handling need is special, Yoder can engineer a unit for you, based upon the most complete experience in the industry.

For engineering consultation or product information write to

ENGINEERING YODER MANUFACTURING

The YODER COMPANY

METAL WORKING PRODUCTION MACHINERY

5526 WALWORTH AVE., CLEVELAND 2, OHIO

New Literature

▲ A new 8-page illustrated book No. 2045 on a complete line of shaft couplings is announced by Link-Belt Company. Sizes, dimensions and list prices are given for couplings of flexible, rigid flanged face and compression types, with special emphasis on the type "RC" roller chain coupling.

Detailed information is also given on protective casings for the "RC" coupling. This includes two styles of revolving casing ("R" and "P") and a type "S" stationary-mounted casing. The Type "P" is a plastic casing; the others are made of steel.

A copy of new book No. 2045 may be obtained by writing direct to Link-Belt Company at Philadelphia, Chicago, San Francisco, or other offices of the company.

▲ Bulletin No. 451 just issued by the Brown Fintube Company, describes a new steam tank heater that speeds the unloading of materials whose viscosity can be lowered by heating. Dimensions and weights of heaters for use with tank cars and trucks are given. Write The Brown Fintube Company, 160 Filbert Street, Elyria, Ohio.

▲ A new bulletin, describing a luminous flame burner for steel mill reheating furnace operations which is available as a combination burner designed to use gas and oil, has been issued by the Bloom Engineering Company.

This bulletin includes engineering data developed from practical steel plant tests. A valuable curve is presented which gives the radiating power of luminous flames at various flame temperature and steel surface temperature. This curve eliminates much tedious and often inaccurate calculation.

An important feature of the Bloom long flame burner is its availability as a combination burner for either gas or oil, with provisions for switching from one to the other with no loss of production. Other applications of the burner include its use in slow-cooling pits, annealing furnaces, heat treating operations, large and small forging furnaces, and car-type annealing furnaces. Bulletin No. 1001 is available by writing the Bloom Engineering Company, Pittsburgh, Pennsylvania.

▲ An interesting and valuable handbook on pumps has just been issued by Marlow Pumps of Ridgewood, New Jersey. Entitled "Self-Priming Centrifugal Pumps," the treatise sets forth, in easy-to-understand style, the principles of centrifugal action, the physics of pumping and the evolution of self-priming centrifugal pumps.

Besides giving basic engineering information, the booklet tells the difference between the types of self-priming centrifugals, points out where self-primers can be used with best effect, and details how to install and care for them.

Copies of the handbook may be had without cost by writing to Marlow Pumps, Ridgewood, New Jersey.

▲ Bailey Meter Company, Cleveland 10, Ohio, has published bulletin No. 230-A featuring Bailey Pyrotron electronic resistance thermometers in indicating, recording and controlling models, for temperature ranges between the limits of minus 100 F and plus 1200 F.

The instruments are said to be well suited for marine, mobile or other classes of severe service since no galvanometers or millivoltmeters are used. No parts move in the measuring circuit except during temperature changes.

The 12-page bulletin lists outstanding features, describes the electronic detector and motor control, gives definite information on ranges, power supply required, speed of response, accuracy, sensitivity, installation, standard chart ranges, automatic control application, alarm contacts, temperature sensitive elements, and measuring circuits.

▲ The first issue of Westinghouse Newsfront, a new monthly publication by the Westinghouse Electric and Manufacturing Company, appeared in April.

The four-page report, printed in two colors and illustrated with drawings and photographs, will contain short articles describing the latest achievements by the company in the fields of scientific research, engineering and production. Featured in the first issue are a round-up on the company's annual report to stockholders, a story on a new application of the Precipitron air-cleaner for the removal of fly-ash, and a picture page illustrating recent Westinghouse developments.

Requests to be placed on the mailing list should be addressed to the Editor, Westinghouse Newsfront, 306 Fourth Avenue, Box 1017, Pittsburgh, Pennsylvania.

▲ A new publication on Rotameters issued by Cochrane Corporation of Philadelphia contains in addition to catalog material on the Cochrane line, helpful data on the selection of a Rotameter for any particular service. Specific gravities of gases and of various metals used in floats are given, together with formulae for converting water and air capacities to terms of other liquids and gases. Other selection factors, such as pressure drop, length of scale and float material are covered in this interesting publication, No. R-100A, a copy of which may be had by addressing Cochrane Corporation, Philadelphia 32, Pennsylvania.

▲ The Automatic Transportation Company, Division of The Yale and Towne Manufacturing Company, manufacturers of electric propelled industrial trucks, has just published a new four-page condensed catalog folder. It consists of detailed specifications covering the Transporter, battery powered, hand lift truck, and Automatic electric industrial power lift trucks.

This condensed catalog folder will be useful to manufacturers and in all lines of business, particularly those who are planning postwar operations.

Copies are available and will be sent without charge upon request addressed to Automatic Transportation Company, 101 W. 87 Street, Chicago 20, Illinois.

▲ Aircraft companies and aircraft part manufacturers throughout the country will examine with much interest the new manual of Aircraft Materials recently issued by the American Steel and Wire Company, a U. S. Steel subsidiary.

The manual contains data on all types of cold-rolled strip, wire and wire products. The section on control cables fully explains their nature and characteristics as well as the intricacies of splicing and swaging and the weight and strength of various cables. Other sections deal with cold-rolled strip steel, U. S. S. stainless steel, cold-finished bars and springs. Also included in the manual are general

on KEYSTONE ELECTRIC MOTOR END BELLS

How many production hours are lost in your plant when your crane motors break down and must be repaired or rebuilt due to oil and dirt on the commutators? We believe the most definite — the most certain way to keep these vital motors running years longer and to cut maintenance costs far below present levels is with the installation of KEYSTONE END BELLS.

This is a new principle of end bell design and transforms your motor from a sleeve bearing to anti-friction Ball bearing installation. This bearing is *grease* lubricated, completely and absolutely sealed. Where dust and dirt-laden air circulate through the motor, very very little stays for no oil is present to help build up the great mass of dirt found in most oil lubricated motors.

Motors equipped with KEYSTONE END BELLS are clean and efficiency is at top level years after installation, while sleeve bearing motors operating on the same job and under identical conditions usually have been repaired many times.

We believe the FACTS, the maintenance record on thousands of installations warrant your immediate investigation of KEYSTONE END BELLS. Not only for crane motors, but *any* motor in your plant, any size, any make.

The illustration above shows two sizes of crane motor end bells, the original casting and the Keystone design. They are easily installed and bolt holes duplicate that of the original.

THE OHIO BALL BEARING CO.

6531 EUCLID AVE. **CLEVELAND 3, OHIO**

BRANCH OFFICES: Canton, Dayton, Columbus, Akron, Cincinnati, Youngstown, Charleston, Wheeling, Fort Wayne, Indianapolis, Muncie, Terre Haute

engineering tables and facts on products of the Wire Company other than aircraft materials.

Due to government restrictions on paper, it will not be possible to make wide distribution of the manual at present. Requests for the manual should be made on company letterheads by members of the executive engineering personnel of aircraft companies and aircraft part manufacturers.

▲ A new data bulletin on motor-driven vent sets has been issued by Buffalo Forge Company, Buffalo, New York. This bulletin, No. 3499, gives physical data, dimensions and ratings on "Limit-Load" belt-driven fans up to size 5, on cast iron "baby" vent sets, on direct-connected "Limit-Load" Fans up to size 4½, and on "Shortboy" Units in capacities up to 20,700 cfm. The fans listed in this bulletin are largely used for industrial and commercial ventilating work.

▲ A bulletin just issued by Sauereisen Cements Company gives detailed information regarding Sauereisen acid-proof cement No. 31, setting forth its advantages, suggested uses, directions for use, etc. Other products of the company are also listed. Copies of the bulletin may be had upon request to Sauereisen Cements Company, Sharpsburg, Station, Pittsburgh 15, Pennsylvania.

▲ H. K. Porter Company, Inc., builders of locomotives, have just issued a new 44-page catalog on diesel-electric locomotives. In addition to giving complete specifications on both narrow and standard gauge locomotives ranging from 30 to 100 tons, the catalogue reveals pertinent engineering and construction data. Diesel-electric advantages and necessary information for selecting the proper type of locomotive are also considered.

A copy of this catalogue, No. L-45-A, may be obtained by writing to H. K. Porter Company, Inc., Pittsburgh 22, Pa.

▲ "Induction Heating and Melting in Industry" is a new bulletin published by Ajax Electrothermic Corporation that covers nearly every job being done today by high-frequency heat — that 29-year old tool of industry.

The booklet gives a great deal of information and basic data, starting off with the history of induction heating, and a description of what it is. The bulletin contains many pages of interesting applications showing how high-frequency heat can be put to work in plants to save time, produce more accurate results, reduce spoilage, and to do heating jobs that couldn't be done before. Bulletin No. 25 is 28 pages overall, size 8½ x 11 in., and is well illustrated. Copies can be had by writing to Ajax Electrothermic Corporation, Ajax Park, Trenton 5, New Jersey.

▲ The Optimus Equipment Company, 169 Church Street, Matawan, New Jersey, manufacturers of washing, rinsing, pickling and drying equipment for metal parts, has just issued bulletin 4E2, entitled "Batch Cleaning in Portable Metal Washing Machines for Production Maintenance and Repair." This bulletin describes portable machines of the dip-agitating type (single and double load) and the spray type. All of these machines can be used for cleaning, washing, paint stripping, rust pre-

MODERNIZE YOUR COVER

Annealing Furnaces

FOR

COILED STRIP
FLAT SHEETS
ROD AND WIRE

GET MORE

PRODUCTION
HIGHER FUEL EFFICIENCY
METALLURGICAL UNIFORMITY
LOWER OPERATING COSTS

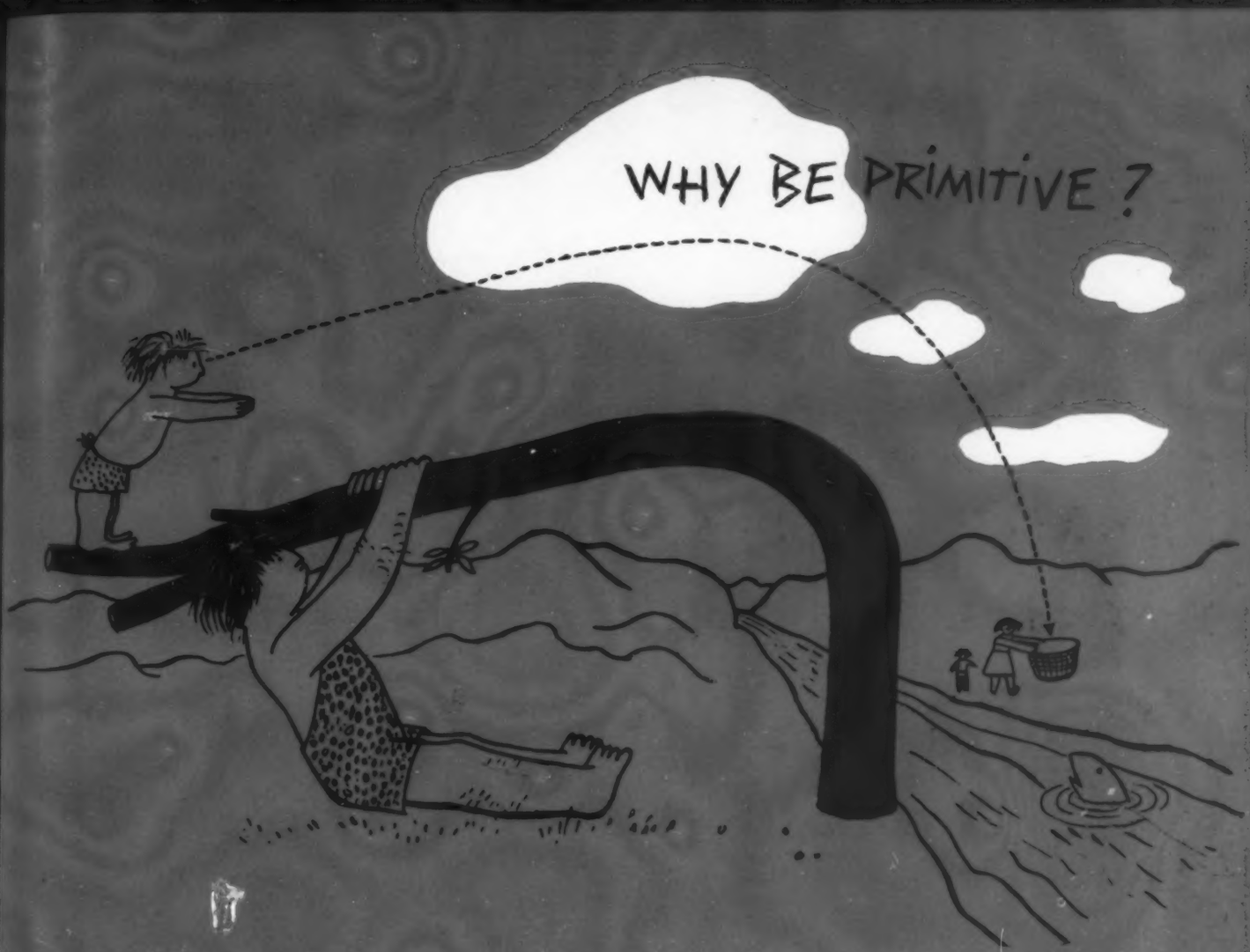
Let us tell you how this amazing development in direct firing of annealing furnaces is now working in the steel industry.

FURNACE ENGINEERS, INC.

1551 WEST LIBERTY AVE. (Fieldbrook 7727) PITTSBURGH 26, PA

ANNOUNCEMENT

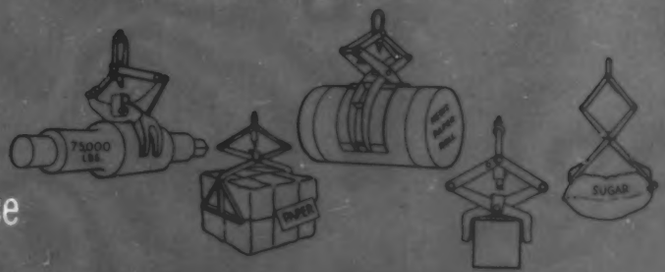
Mr. Harry Dobrin, for many years consultant on combustion problems with various steel companies, and more recently associated with furnace manufacturers, is now Vice President of Furnace Engineers, Inc.



Handle your materials the modern way—faster, safer, more economical way

Industries of every kind are *saving*—time—money—accidents—with Heppenstall Safe-T-Tongs—The Tongs that pick-up, land and release a load simply by raising and lowering the crane. Heppenstall Tongs are automatic—positive—proved—and they are adaptable to any weight, shape or type of material. If the job is repetitive, Heppenstall Tongs offer you an important help. Our Tong Book will show you how and why—write for your copy.

Heppenstall Company. Pittsburgh, Pennsylvania.
Makers of fine forgings for over 55 years.



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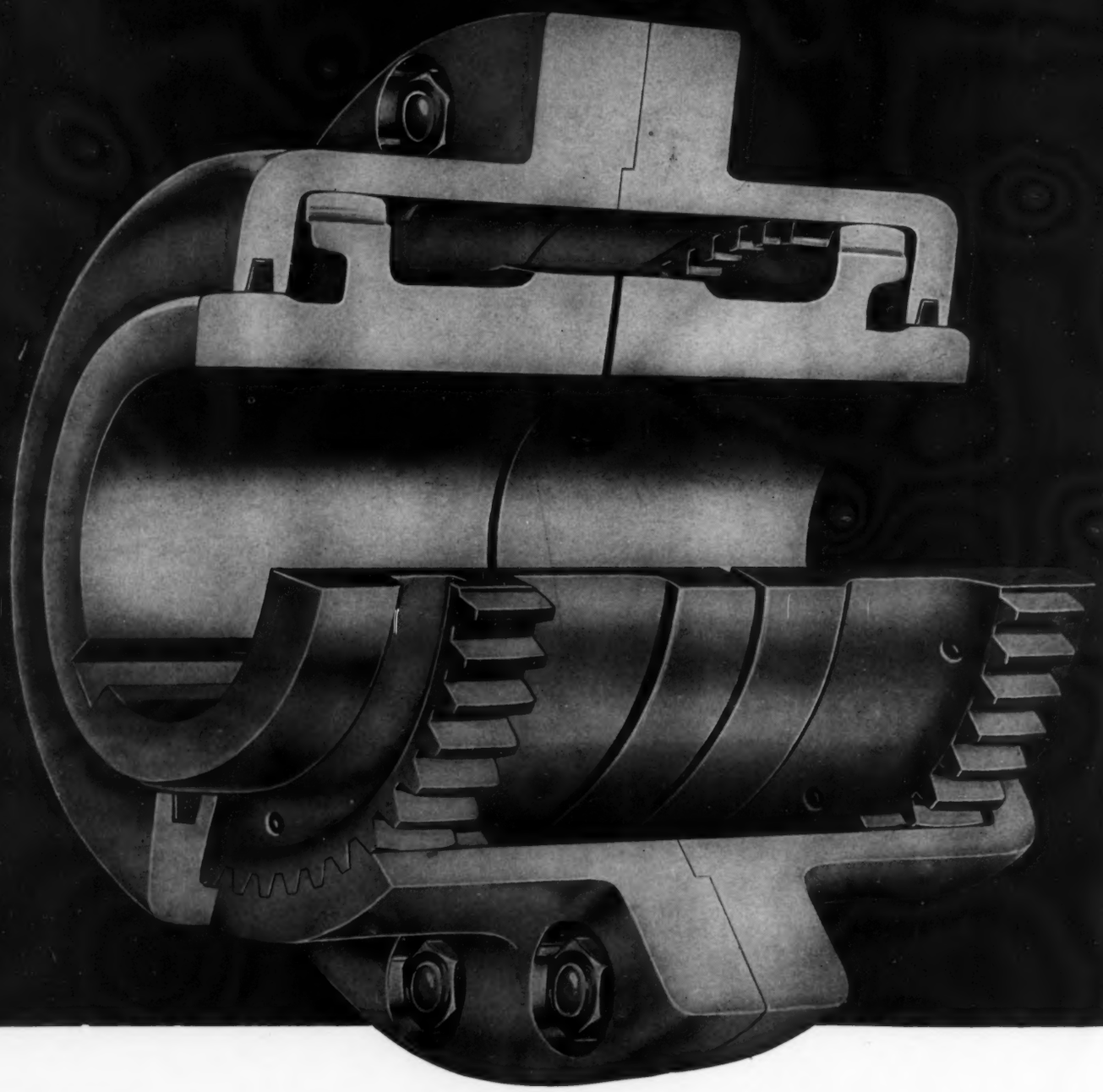
HEPPENSTALL SAFE-T-TONGS

POOLE



COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

vention, rustproofing, rinsing, chemical treatment, coating, etc.

▲ A 4-page folder issued by the A. F. Holden Company shows tool room and small production type furnaces in three standard sizes. On the inside of the folder the Holden heat treating baths are listed with their respective melting points, operating ranges and uses. Copies of the bulletin T-230 may be had upon request to the A. F. Holden Company, New Haven (8), Connecticut.

▲ A new 16-page illustrated booklet on "How and Why Cathode Ray Tubes Work" including a discussion of complete television set-ups, has been announced by North American Philips Company, Inc., 100 East 42nd Street, New York.

The text material was written by J. R. Beers, development engineer, and is divided into four sections. Early history, mathematical concepts, present-day problems, are treated in Section 1. Schematic diagrams help to convey the idea of how the tube functions. The subject of screens and their characteristics is treated at some length.

Section 2 takes up C-R tube manufacturing problems. Curves and pictorial illustrations are used to describe materials, assembly and visual inspection.

Testing of C-R tubes is the subject matter of Section 3. Many photos of screen patterns help to identify the wide variety of defects that are enumerated.

Section 4 goes into special C-R tube designs. Here complete television set-ups are shown and discussed along with lens systems, color filters and three-color screens.

▲ A new electric timer bulletin, No. 1100, has just been released by the C. H. Stoelting Company, Industrial Division, 424-P North Homan Avenue, Chicago 24, Illinois.

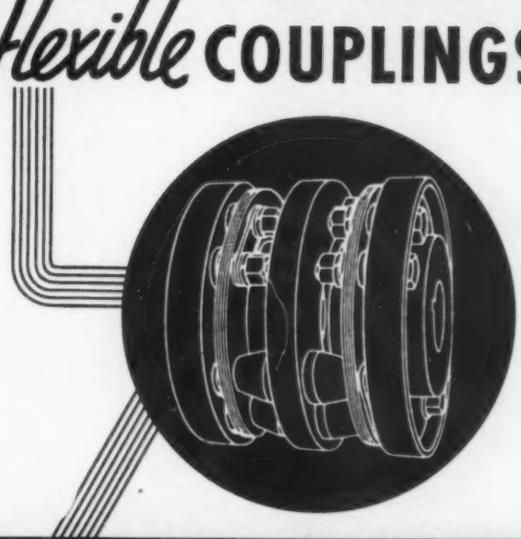
The new bulletin describes table model stop clocks, wall model stop clocks, precision chronoscopes, combination timers and impulse counters, stop watch controllers, and spring wound X-ray timers.

These Stoelting timers have wide application in industrial and laboratory testing, such as in measuring start-to-stop intervals of relays and instruments and for checking sequence operations. Circuit diagrams are included to show correct methods of connecting the various timers in test circuits.

▲ "The A B C of Electronic Heating," just published by Scientific Electric, is a sixteen-page booklet written for both engineer and manufacturer on the subject of electronic heating.

All the essential facts are discussed in a language stripped of confusing terminologies. It contains a brief record of the historical background and development of electronic heating — explains the principle of its operation — describes the two chief methods and fields of application and lists many proved present day uses. Many illustrations are used to make all the important parts of the text easily understood and several types of high frequency generators are shown. This is an important handbook to have if you are considering the application of electronic heating to manufacturing methods. The booklet is available upon request by writing to Scientific Electric, 107-119 Monroe Street, Garfield, New Jersey.

THOMAS
Flexible COUPLINGS



TYPE DBZ
TYPE DSM
TYPE CM
TYPE AM
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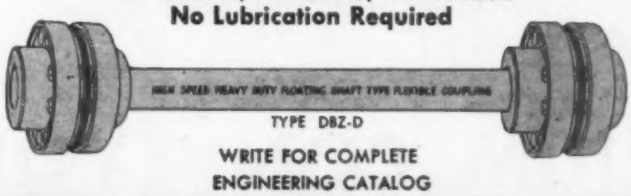
TYPE SS

Eliminate BACKLASH, FRICTION, WEAR AND CROSS-PULL
the four destructive evils of other types and makes of couplings that prevent a permanent care-free installation.

The Thomas All-Metal Coupling has:
No Chains, No Gears, No Rubber.
No Lubrication Required



TYPE DBZ-D

WRITE FOR COMPLETE ENGINEERING CATALOG

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA

THIS "VACUUM" CONVEYOR UNIT...

SPECIALLY DESIGNED AND BUILT

by the Vacuum Conveyor Company, for a multiple open hearth furnace installation in a large steel plant in the Pittsburgh district, to remove open hearth furnace flue dust by the well proven Vacuum method.

For Further Particulars, Write to

VACUUM CONVEYOR COMPANY

SALES OFFICES: 313 NORTH 20TH STREET, PHILADELPHIA 3, PA.

GENERAL OFFICES: CURREN ARCADE BLDG., NORRISTOWN, PA.

Personnel News

Gordon Gage, former general superintendent, American Rolling Mill Company, Butler, Pennsylvania, has been made manager of the Butler division, succeeding **Harry Holiday** who has resigned because of ill health.

Mr. Gage joined Armco in 1910 as an electrician and for a number of years worked days and attended University of Cincinnati at night. He has been at Butler since 1929, and general superintendent since 1933.

Roy P. Tooke, assistant chief of the general engineering department of American Rolling Mill Company at Middletown, Ohio, has been transferred to Butler as general superintendent. Mr. Tooke joined Armco in 1922 and has had diversified operating experience. He served at Butler as works engineer from 1934 until 1942, when he was assigned to direct the construction of a steel plant in Mexico for Armco International Corporation.

William F. Tuttle has been appointed assistant chief engineer, general engineering division of The American Rolling Mill Company. Mr. Tuttle, a graduate of Massachusetts Institute of Technology, joined the Armco organization in 1922 as an engineer in the Ashland construction department. He was transferred to the Middletown, Ohio, engineering department and became development engineer in 1930. Later in that year he became works engineer, and on December 1, 1944 was made assistant to the manager of the East Works plant, the position he held until his recent promotion.

Fred J. Beckmann has been made superintendent of Saucon Division roll shop, Bethlehem Steel Company, Bethlehem, Pennsylvania. Mr. Beckmann has been with Bethlehem since 1918, when he was graduated from Lehigh University in mechanical engineering. Until 1921 he worked in the drafting room and in plant maintenance, and was then transferred to the engineering department on power engineering work. In 1934 he moved to the Saucon roll shop as a designer, becoming chief roll designer in 1941 and assistant superintendent of the roll shop in 1944.

R. J. Linney has been made district manager of the Port Henry District and **W. J. Linney** district manager of the Chateaugay District of Republic Steel Corporation. The appointments follow the resignation of **J. R. Linney** who has been district manager of Republic's combined Northern New York mining operations and who has resigned to enter the mining consulting field.

R. J. Linney was formerly general superintendent at Port Henry and W. J. Linney general superintendent at Chateaugay.

Robert J. Overstreet has been appointed representative in North and South Carolina, and Eastern Georgia for Reliance Electric and Engineering Company, Cleveland, Ohio. Mr. Overstreet is a graduate of the Virginia Polytechnic Institute. Formerly employed by J. E. Sirrine, Greenville, South Carolina, and more recently as shipyard electrical engineer at the J. A. Jones Construction Company, Brunswick, Georgia, Mr. Overstreet will make his headquarters in Greenville, South Carolina.

J. J. Roessle recently joined the Hyatt Bearings Division of General Motors as a sales engineer at their Pittsburgh divisional sales Office. After his graduation from Lehigh University in 1933 Mr. Roessle was affiliated with the Mesta Machine Company and was with them until coming to Hyatt.

Franklin Farrel, Jr. resigned as chairman of the board of directors of Farrel-Birmingham Company, Inc., and **Alton Austin Cheney** was elected to succeed him.

GORDON GAGE

ROY P. TOOKE

WILLIAM F. TUTTLE

Mr. Farrel is the grandson of Almon Farrel, and the son of Franklin Farrel, Sr., founders of Farrel Foundry and Machine Company, which was started in Ansonia, Connecticut, in 1848. Mr. Farrel has been affiliated with the company in various capacities isnce 1903 and has served on the board of directors since 1904. He will continue as a director and as chairman of the finance committee.

Mr. Cheney, the new board chairman, is also a direct descendant of the company's founders, being a great grandson of Franklin Farrel, Sr. He has been a director of Farrel-Birmingham since 1931.

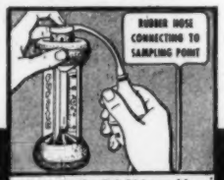
NOW! a Practical Instrument

for DIRECT OXYGEN ANALYSIS

The FYRITE Oxygen Indicator employs the time-tested fundamental FYRITE principle of chemical absorption. It is simple, fast, accurate—requires no setting-up; has no valves, clamps, or leveling bottle to manipulate; makes complete oxygen test in 40 seconds with accuracy within ½ of 1% O_2.

The FYRITE is ideally suited for checking oxygen content in process gases, heat-treating atmospheres, hydrogen-cooled generators, and in the nitrogen over the oil in large transformers. It is indispensable for determining combustion efficiency where mixed fuels of differing hydrogen-carbon ratios are fired together. For complete data on FYRITE Oxygen Indicator, send for Leaflet 700.

$24.50 COMPLETE F.O.B. PGH.



FYRITE is EASY to Use

CO_2 INDICATOR designed on same principle ALSO AVAILABLE. Write for Bulletin 341.

BACHARACH INDUSTRIAL INSTRUMENT CO.
7000 BENNETT ST., PITTSBURGH 8, PA.

ELECTRIC DOOR LIFTS
Conveyor and Car Puller Drives

DOOR LIFTS FOR
Furnaces · Ovens · Industrial Buildings
DRIVES AND PULLERS FOR
Furnaces · Ovens · Cars · Mixers
NEW PRINCIPLES OF DESIGN
Low in Cost · High in Efficiency
SEND FOR CATALOG

FRED J. RYAN COMPANY
WYNCOTE, PENNA., U.S.A.

O. L. Weber, formerly superintendent of Industrial relations, Edgar Thomson Works, Carnegie-Illinois Steel Corporation, has been appointed executive assistant to the director of industrial relations of the Pittsburgh district of the company. Mr. Weber began his employment with this U. S. Steel subsidiary at the company's Gary Works where he served in various capacities until 1941. At the time of his transfer he had become assistant to the superintendent of maintenance. He was then assigned to the Edgar Thomson Works, Braddock, Pennsylvania, as superintendent of the plant's industrial relations department, remaining in that position until his present promotion.

Mr. Weber was born in Chicago, Illinois, and studied electrical engineering at the University of Wisconsin and Armour Institute. During World War I he served as a sergeant major in the engineering branch of the AEF.

Lester D. Chirgwin, general manager of the Buffalo plant of Farrel-Birmingham Company, Inc., was elected vice president in charge of manufacturing, and **Franklin Farrel, 3rd,** plant manager for Ansonia-Derby plants, was elected secretary and assistant treasurer. Other officers reelected were **Franklin R. Hoadley,** president; **Carl Hitchcock, Armin G. Kessler** and **Austin Kuhns,** vice presidents; and **Frederick M. Drew, Jr.,** treasurer and assistant secretary. **Carl F. Schnuck,** chief engineer of the company, and **William M. Fraser,** general manager of The Atwood Machine Company, Stonington, Connecticut, recently acquired by Farrel-Birmingham, were elected directors.

MICHAEL J. DEVANEY

Michael J. Devaney, who started his steel industrial career 45 years ago as a clerk in the South Chicago plant, was appointed assistant to the manager of Chicago district operations of Carnegie-Illinois Steel Corporation, U. S. Steel subsidiary. He advanced steadily in his South Works association, working through the open hearth department to the superintendency of all steel production and, for the last four years, had been assistant general superintendent of the plant.

John H. Vohr, for the last two years assistant to the general superintendent at South Works of Carnegie-Illinois Steel Corporation has been made assistant general superintendent, succeeding Mr. Devaney. Mr. Vohr is a Cornell university graduate and was commissioned a pilot in World War I. He has previously been associated with the Inland Steel Company, Youngstown Sheet and Tube Company and the Granite City Steel Company.

JOHN H. VOHR

Charles C. Cheyney has been appointed to the position of sales manager of Buffalo Forge Company. Mr. Cheyney was for a number of years Chicago representative of Buffalo Forge Company and in recent years has been assistant sales manager.

E. O. Murdock, who has handled sales and service on Yoder products in the Michigan area for many years, has been transferred to Detroit as manager of a new office and factory branch of the Yoder Company, Cleveland, Ohio.

Sam K. Beetham, advertising and public relations counselor, has recently joined the firm of McClure and Wilder, Inc., of Warren, Ohio, as vice president in charge of public relations and new business departments. Mr. Beetham recently left the Owens-Illinois Glass Company of Toledo where he had been advertising manager of The Libbey Glass Division and the Owens-Illinois Can Company prior to its acquisition by Continental Can Company. During most of the years spent with Owens-Illinois he handled all the conventions and trade show activities of that Company and its subsidiaries.

Obituaries

John Robert Hagemann, 44, manager of engineering in the steam turbine department of the Allis-Chalmers Manufacturing Company, died February 15.

Born in Switzerland, Mr. Hagemann was a graduate of the Swiss Federal Polytechnic Institute, Zurich, Switzerland, where he was a student of Dr. A. Stodola.

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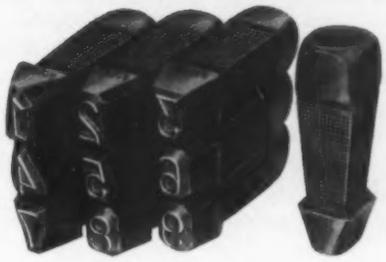

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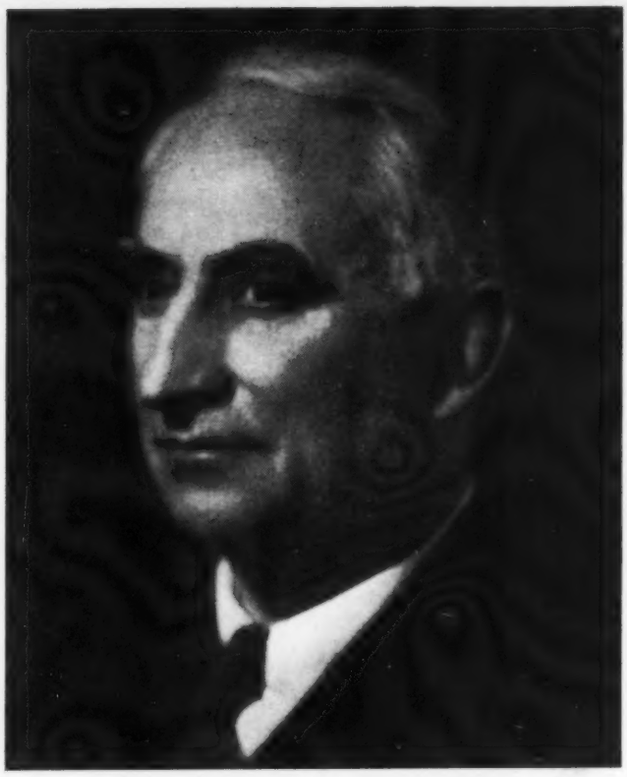
In 1929 he joined Allis-Chalmers, being made assistant engineer in 1934. In 1942 he became engineer in charge of power steam turbine design, and in 1944 he was appointed manager of engineering in the steam turbine department.

L. R. Palmer, a past president (1911) of the Association of Iron and Steel Engineers and a founder and early president of the National Safety Council, died in New York on March 24. Born in Iowa 70 years ago, Mr. Palmer was a graduate of Princeton, where he was an all-American end. He became the first safety director of an industrial concern when, as electrical superintendent for Jones and Laughlin Steel Corporation, he was at his own suggestion appointed to improve safety conditions.

Mr. Palmer was chairman of the Association committee which organized the First Cooperative Safety Congress, held in Milwaukee, Wisconsin, in 1912, from which grew the National Safety Council. Following his interests in safety, Mr. Palmer later was associated with the Pennsylvania State Department of Labor and Industry, and then became conservation engineer with the Equitable Life Assurance Society of the United States. He was more recently connected with the National Safety Council as vice president.



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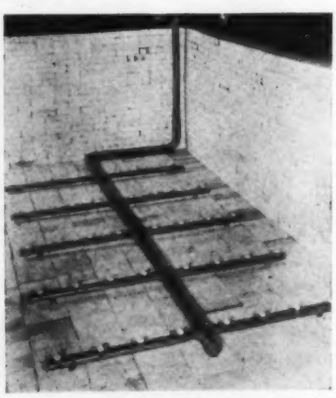

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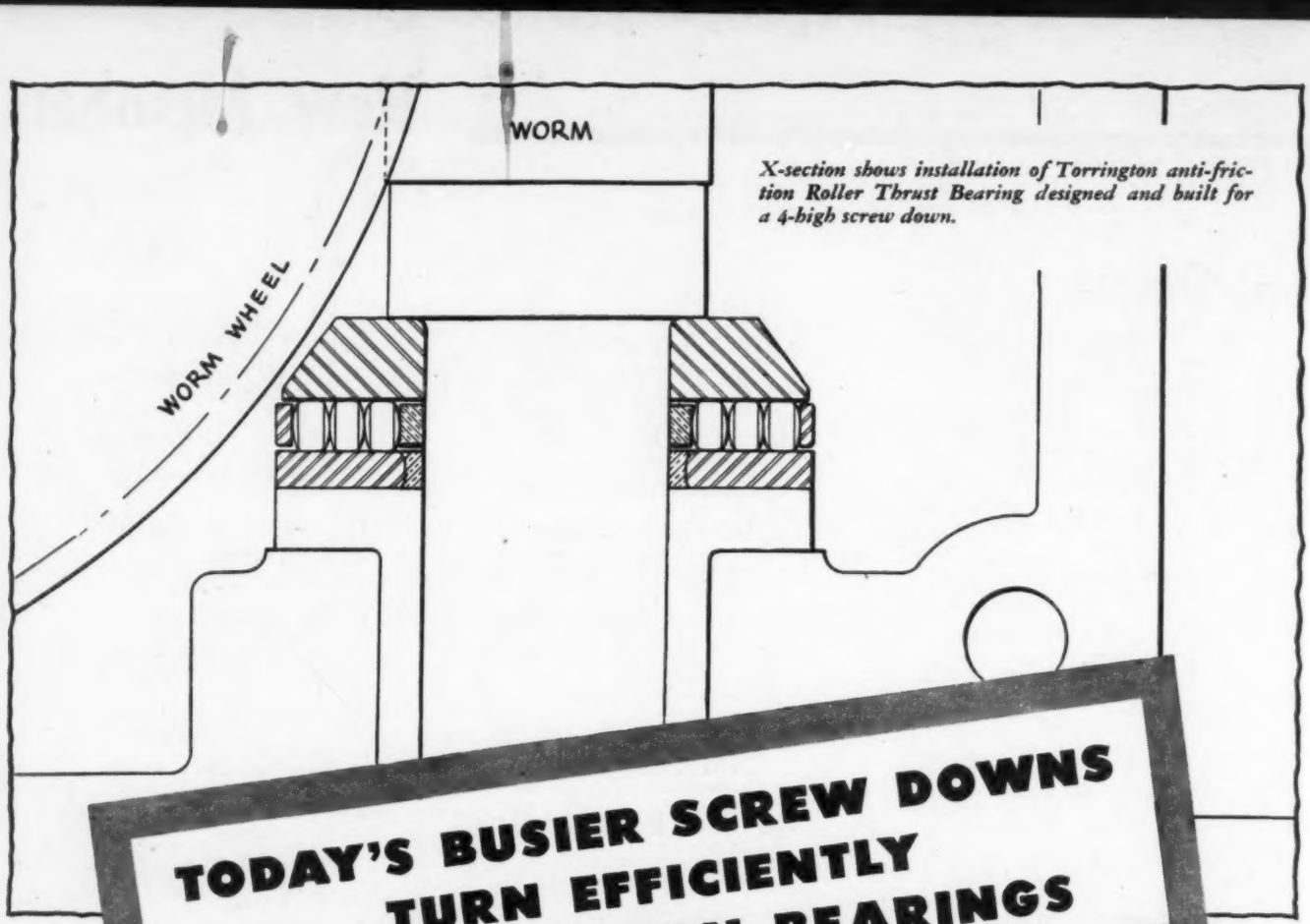

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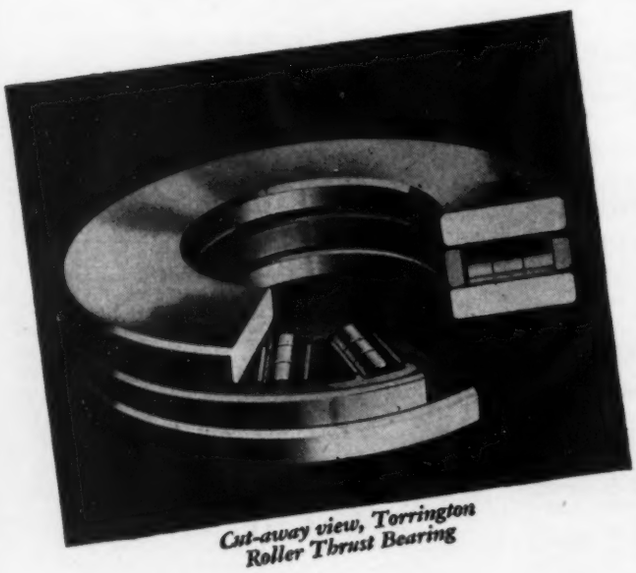

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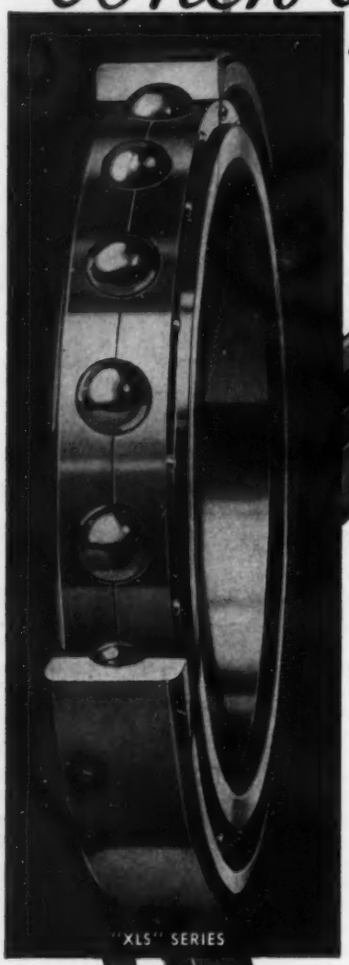
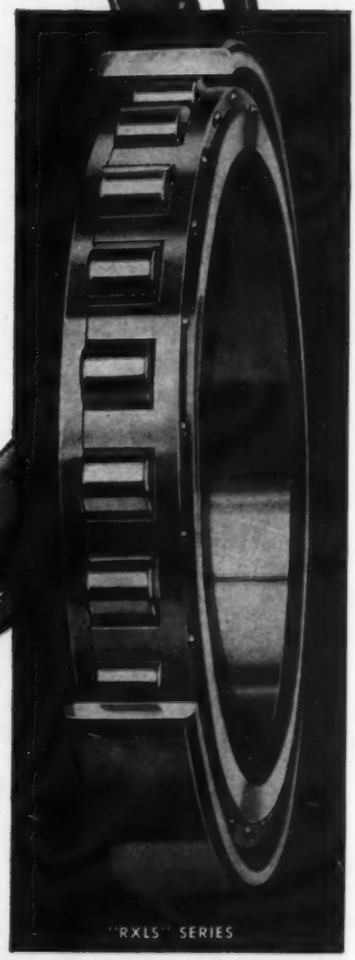


HAVING bores abnormally large, as compared with the outside diameter, they offer definite advantages under certain conditions found in machine design. You may have them in several different types, *affording compactness, light weight, and greater latitude in your design.*

There are several lines of very light type ball bearings, which include the "S" starting at 1/8" bore, and the "XLS" starting at 1 3/8" bore, running up to a maximum of 21" bore and 28" outside diameter. And in very light type roller bearings, there is the "RXLS" Series, paralleling the "XLS" in size range.

Why not let our engineers tell you more about these Very Light Precision Bearings? Write for the Catalog.



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And *greater earnings for you,* too—because the new Cleveland Speedaire Worm Gear Unit gives you *More Horsepower for Your Dollar!*

Speedaire—the new Fan-Cooled Worm Gear Reducer—offers as much as twice the capacity of standard worm units of equal frame size, when operated at usual motor speeds. Heat generated during operation is literally *scoured off* the outer surfaces of the oil reservoir by a high-velocity air stream.

The greatly-increased capacity of the new Speedaire will permit you to use these Units in place of other types—giving you all of the inherent advantages of a right-angle worm drive.

Write for your copy of the new Speedaire Catalog. The Cleveland Worm & Gear Company, 3278 East 80th St., Cleveland 4, Ohio.

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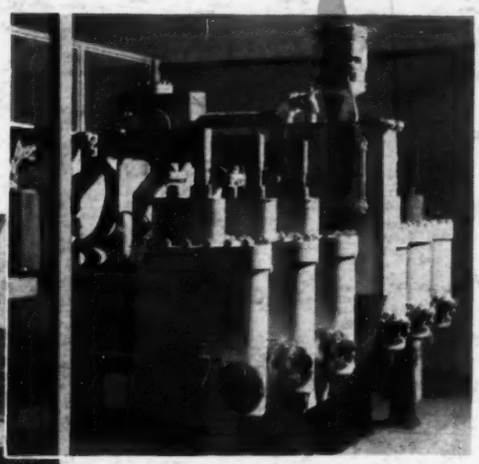
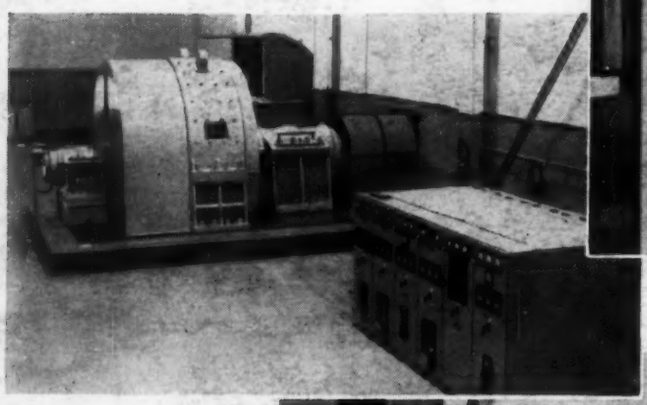
SPEEDAIRE *Worm Gear Reduction Units*
FAN COOLED

POWER AND DRIVE

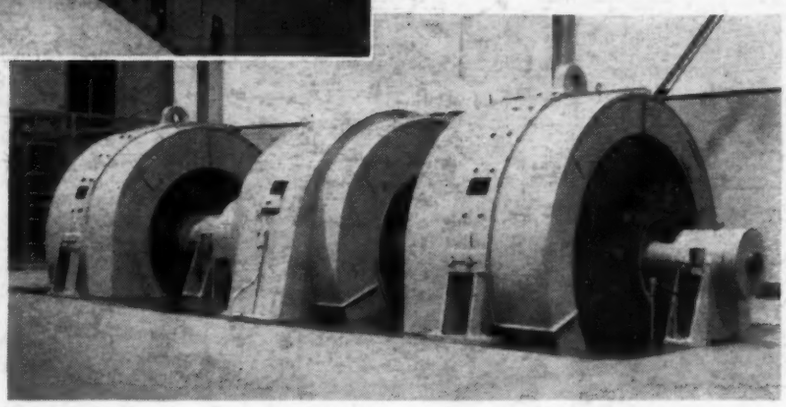
for Kaiser's 29-inch Structural Mill



For d-c auxiliary power—G-E 1500-kw mercury-arc rectifier



Driving nonreversing structural mill—5000-hp, 70/150-rpm, d-c motor. In foreground—2300-volt G-E metal-clad switchgear



Supplying power for main drive—4000-kw, synchronous-motor-driven M-G set

A LARGE part of the electric equipment for the Iron and Steel Plant of Kaiser Company, Inc., at Fontana, California, was furnished by General Electric. In the above pictures you see four installations for the 29-inch structural mill—equipment that powers and drives the machinery supplying vital steel for tomorrow's battles.

During the many years General Electric has been associated with the steel industry, we have developed specialists to co-ordinate and standardize electric equipment specially suited to this industry. And for all phases of processing where electric power is used, you'll find G-E equipment available to solve the problems of the mill engineer. *General Electric Company, Schenectady 5, N. Y.*

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